ENVIRONMENTAL ASSESSMENT BOARD

Ontario

ONTARIO HYDRO DEMAND/SUPPLY PLAN HEARINGS

VOLUME: 130

DATE: Wednesday, April 8, 1992

BEFORE:

HON. MR. JUSTICE E. SAUNDERS	Chairman
DR. G. CONNELL	Member
MS. G. PATTERSON	Member

FARR & ASSOCIATES REPORTING INC.

(416) 482-3277

2300 Yonge St. Suite 709 Toronto, Canada M4P 1E4

A P P E A R A N C E S

B. CAMPBELL L. FORMUSA B. HARVIE J.F. HOWARD, Q.C. J. LANE G. A. KARISH	ONTARIO HYDRO
J.C. SHEPHERD I. MONDROW J. PASSMORE	IPPSO
R. WATSON A. MARK	MUNICIPAL ELECTRIC ASSOCIATION
S. COUBAN P. MORAN J. MacDONALD	PROVINCIAL GOVERNMENT AGENCIES
C. MARLATT D. ESTRIN H. DAHME	NORTH SHORE TRIBAL COUNCIL, UNITED CHIEFS AND COUNCILS OF MANITOULIN, UNION OF ONTARIO INDIANS
D. POCH D. STARKMAN D. ARGUE	COALITION OF ENVIRONMENTAL GROUPS
T. ROCKINGHAM	MINISTRY OF ENERGY
B. KELSEY L. GREENSPOON P. McKAY	NORTHWATCH
J.M. RODGER	AMPCO
M. MATTSON T. McCLENAGHAN	ENERGY PROBE
A. WAFFLE	ENVIRONMENT CANADA
M. CAMPBELL M. IZZARD	ONTARIO PUBLIC HEALTH ASSOCIATION, INTERNATIONAL INSTITUTE OF CONCERN FOR PUBLIC HEALTH
G. GRENVILLE-WOOD	SESCI

A P P E A R A N C E S
(Cont'd)

D. ROGERS	ONGA
H. POCH) J. PARKINSON)	CITY OF TORONTO
R. POWER	CITY OF TORONTO, SOUTH BRUCE ECONOMIC CORP.
S. THOMPSON	ONTARIO FEDERATION OF AGRICULTURE
B. BODNER	CONSUMERS GAS
J. MONGER) K. ROSENBERG) C. GATES)	CAC (ONTARIO)
W. TRIVETT	RON HUNTER
M. KLIPPENSTEIN	POLLUTION PROBE
N. KLEER) J. OLTHUIS) J. CASTRILLI)	NAN/TREATY #3/TEME-AUGAMA ANISHNABAI AND MOOSE RIVER/ JAMES BAY COALITION
T. HILL	TOWN OF NEWCASTLE
M. OMATSU) B. ALLISON) C. REID)	OMAA
E. LOCKERBY	AECL
C. SPOEL) U. FRANKLIN) B. CARR)	CANADIAN VOICE OF WOMEN FOR PEACE
F. MACKESY	ON HER OWN BEHALF
D. HUNTER) M. BADER)	DOFASCO
B. TAYLOR) D. HORNER) H. WATSON)	MOOSONEE DEVELOPMENT AREA BOARD AND CHAMBER OF COMMERCE

A P P E A R A N C E S
(Cont'd)

T. HEINTZMAN D. HAMER C. FINDLAY	)))	ATOMIC ENERGY OF CANADA
P.A. NYKANEN	)	CANADIAN MANUFACTURERS ASSOCIATION - ONTARIO
G. MITCHELL		SOCIETY OF AECL PROFESSIONAL EMPLOYEES
S. GOUDGE		CUPE
D. COLBORNE		NIPIGON ABORIGINAL PEOPLES' ALLIANCE
R. CUYLER		ON HIS OWN BEHALF
L. BULLOCK L. CHAN	))	CANADIAN NUCLEAR ASSOCIATION

INDEX of PROCEEDINGS

L I S T o f E X H I B I T S

L I S T o f E X H I B I T S
(Cont'd)

L I S T o f U N D E R T A K I N G S

TIME NOTATIONS

---Upon commencing at 10:04 a.m.

THE REGISTRAR: Please be come to order. This hearing is again in session. Please be seated.

THE CHAIRMAN: Ms. Harvie?

MS. HARVIE: Mr. Chairman, both Mr. Campbell and I will be sitting in today. Mr. Campbell will be joining us at about 12:15.

There are some exhibits that Hydro has distributed to full- and part-time parties, and I just wanted to read the exhibit numbers onto the record as I understand is now the practice.

The first one is Exhibit 452C, and this is entitled Updated Figures from Chapters 14 and 15 of the Demand/Supply Plan Report, Exhibit 3.

The second is Exhibit 535, which is a Public and Government Review and Input into Ontario Hydro's Demand/Supply Planning Process.

The third is Exhibit 536, which is Energy Price Trends Report, Annual Review, November, 1991.

And the fourth is Exhibit 452D, entitled An Assessment of Over/Under Planning Costs.

As well, in the letter that was distributed to all the parties signed by Mr. James Lane of our firm there were several pages attached as errata to Exhibits 452A and 452B, and the understanding is

that those pages can simply be inserted into the exhibits that parties already have.

---EXHIBIT NO. 452C: Updated Figures from Chapters 14 and 15 of the Demand/Supply Plan Report, Exhibit 3.

---EXHIBIT NO. 535: Public and Government Review and Input into Ontario Hydro's Demand/Supply Planning Process.

---EXHIBIT NO. 536: Energy Price Trends Report, Annual Review, November, 1991.

---EXHIBIT NO. 452D: An Assessment of Over/Under Planning Costs.

I also understand that Mr. Daly has a couple of corrections to make to the record, so I will let him do that. Thank you.

DAVID WHILLANS,
KURT JOHANSEN,
FRANK CALVIN KING,
WILLIAM JOHN PENN,
IAN NICHOL DALY; Resumed.

MR. DALY: I would like to make couple of corrections to yesterday's transcript. The first one is at page 22730. We were discussing at that point the difference between capability factor and capacity factor, and I was providing as an example of the difference the experience of EDF in France.

On line 19 of page 22730 I said:

> Capability factors are, as you know, relatively low.

That should have read:

Capacity factors are, as you know, relatively low.

So line 19, if you change "capability" to "capacity" that corrects that one.

The second point is on page 22766, and at the foot of that page Mr. Poch asked me a question relative to page 27 of Exhibit 519, which was a table of world lifetime average capacity factors by reactor type, and the following page has a discussion on that.

I indicated at the top of that page that only Darlington 2 was included in that table. I have since checked it again, and, in fact, Darlington 1 and Darlington 2 are both included in that table. The table is not marked as such, but it is a table of since first electricity.

THE CHAIRMAN: I'm sorry, of what?

MR. DALY: It is a table of numbers since first electricity as opposed to a table since in-service. So the table on page 27 of Exhibit 519 is a table of statistics since first electricity and as such includes both Darlington 1 and Darlington 2.

I hope that clarifies that.

THE CHAIRMAN: All right.

CROSS-EXAMINATION BY MR. D. POCH (Cont'd):

Q. Mr. Daly, just on that last point

then, I am correct in understanding that the figure of 73.3 would not include any of the Darlington reactors before first electricity, and so for Unit 1 the various delays, for example, before first electricity, which was relatively recent, would not be included in there?

MR. DALY: A. That's correct. It's just since first electricity.

Q. All right.

THE CHAIRMAN: It is a new term to me. I don't know if it is to others. What is the difference between in-service and first electricity?

MR. DALY: First electricity is the point at which we first synchronize to the bulk electricity system. Following that there is a period of commissioning where we take the unit through the various levels of power, and this typically last some three to six months. After that period of commissioning when you are satisfied that the unit is operating reliably you then place the unit in-service.

So there is typically about six months between first electricity and in-service.

THE CHAIRMAN: Thank you.

MR. D. POCH: Q. Now, Mr. Daly, we were discussing the various factors affecting your performance indices and your estimates, and I just

wanted to touch on the problems at Darlington and see how your forecasts, which you indicated were based on...I think the phrase was "reasoned engineering judgment", had or hadn't anticipated these.

You indicated at transcript page 21160 at line 22: We have only --

THE CHAIRMAN: Hold it just a minute. What volume is that, please?

MR. D. POCH: I'm sorry, I don't have the volume. That would have been your evidence in chief, I believe. I can get that, Mr. Chairman.

I am told it is 121, Mr. Chairman.

THE CHAIRMAN: Thank you.

MR. D. POCH: Q. And the quote I have from line 22 is:

> We have only had a short period of time with current rotor modifications on Unit 1. However, no problems were evident.

So can you tell us how long you ran with the new rotor, the modified rotor on Unit 1, and indicate why testing was stopped?

MR. DALY: A. That was a period of about four to six weeks. Testing was stopped because we identified some damaged fuel on Unit 1, and the unit

was taken off line to further investigate the fuel problem.

Q. And the damaged fuel is related to the other problem with resonance in the pipes?

A. That's correct, yes.

Q. You went on to say that:

> Further in-service delays due to the generator rotor problems are not anticipated at this time.

Are you comfortable that four to six weeks is a sufficient period of time to test out the rotor modifications?

A. Well, there have been additional tests done at the manufacturer's. I guess there is an implication in these remarks that we have a number of delays caused by the fuel problem, and we feel that, you know, the fuel problem is the dominant one influencing the critical path, and we now have sufficient time to make the modifications on the generator.

Q. Well, Mr. Daly, I understood you had already made the modifications for Unit 1; is that not --

A. For Unit 1, yes.

Q. All right. And the question then is:

Are the modifications sufficient, or do you have to do something more dramatic? And you have indicated you had a four to six week test period.

Can we compare that. How long did Unit 2 run for before the rotor problems became apparent there?

A. My recollection is about three months.

Q. All right. So there is still some potential for, or still some uncertainty about, the adequacy of the fix, if you will?

A. I would say there is some uncertainty. What I was trying to say there was we felt the uncertainty would not influence the critical path, that the fuel problem was more on the critical path.

Q. But you won't know about whether or not this rotor is any good in the long run until after you fix the fuel problem and restart; is that not true?

A. We will have to keep monitoring and inspecting the generator on a routine basis.

Q. So that the critical path, as you say, of the fuel is really not -- it is not providing you with any window you can use to test this rotor. You can't test the rotor without running the unit; is

that fair? You can do some tests, but you are not going to have the operating time until after the fuel problem is cleared up?

A. Well, there are some possibilities of running at lower power where one of the potential modes of operation for Darlington 1 would be to run at approximately 50 per cent power, which would give us some additional experience on the generator.

Q. Though at lower stress levels?

A. Correct, yes.

Q. Now, I guess it is obvious that -- it is ASEA Brown Boveri who built the rotor?

A. Yes.

Q. And ABB and Hydro hadn't caught this initially. So your engineering judgment, if you will, or ABB's engineering judgment which you relied on, wasn't sufficient to find the problem in the first place.

What is your engineering judgment telling you to allow for the possibility of this problem continuing because this fix may not be adequate in your performance indices?

A. I guess we have adjusted our performance indices down in the short term over the next one to two years.

Essentially, we see this as a short-term problem; you know, certainly a significant one, but it is not that unusual for a large plant to experience significant teething problems in its early years, and we have had these in some of our other plants.

[10:15 a.m.]

So we do see it as a short-term problem. Generators have been in use world-wide in many utilities, so there is a lot of world experience in modifying and improving generators.

Q. There was a lot of world experience before they built this generator, too, of course, but that didn't stop the problem.

So I am asking you specifically, in your performance forecast for the coming few years, what specific allowance have you made, for example, with respect to Unit 1 at Darlington for the possibility of continuing rotor problems, is there any specific allowance for that?

A. The allowances we have made are quite high, they are typically for 1993 in our most recent projections, the DAFOR is at 30 per cent for all Darlington units, and that reflects a combination of uncertainty associated primarily with the fuel, but also to some extent influenced by the generator and

other type of commissioning, any operation problems we might anticipate.

Q. So you don't have a specific number you can offer me for the potential risk associated with the rotors?

A. Not for the rotors. No, we feel we have done a number of modifications and new rotors are in order. We feel this is, in general terms, a less significant problem than the fuel, so the fuel tends to dominate our statistics.

Q. You said that. But isn't it true that your performance indices you are, in effect, treating the rotor problem as solved?

A. As I mentioned earlier, we provide a range of performance statistics to power system operations and system planning, and certainly when we talk to both of those groups we indicate, look, there are some continuing uncertainties at Darlington, they will continue to be there in short-term, a major one is the fuel, and I agree, the rotor has been run for a relatively short period of time, it will remain an uncertainty for some time.

Q. So you feel that your general DAFOR allowance is likely sufficient to capture this, but you haven't analyzed it, you haven't put a specific number

on it. I think we can agree with that.

A. We haven't put a specific number on the generator, right.

Q. And you say that the availability of Darlington in the next few years is likely to be dominated by the --

THE CHAIRMAN: Where did he say?

MR. D. POCH: Q. I thought you had just said to me just a few moments ago, Mr. Daly, that you felt that the fuel problem is likely to dominate, I think you used critical path.

MR. DALY: A. That's the major uncertainty facing us at this time.

Q. And in the transcript you said, and this is discussed at three pages further on, at page 21163, starting at line 6, you say:

"We have done a tremendous amount of work to determine the cause of the damage and come up with possible repair strategies. Several possible repair strategies have been proposed."

If we go to the next page you say:

"The use of these new impellers as a fix to the fuel damage problem was based on a computer simulation of the

hydraulics of the heat transport system, and there is some uncertainty as to whether or not this repair will be totally adequate..."

And later below you say:

"If the piping modifications are required, then further in-service delays of about six months per unit will be required."

What have you allowed in your DAFOR for that potential six months outage of the -- I guess it would be of the entire Darlington station?

A. What we have done in this particular place is to reflect the two different potential in-service dates in our business plan.

So with the current in-service dates, the current in-service dates assume basically that seven vane impeller turns out to be the solution, and if it doesn't we have quoted in our business plan the delayed in-service of approximately six months per unit. So that is the way we have treated that one.

Q. So your forecast capability or capacity factor numbers do not include this potential problem, because if it turns out to be a problem you will deal with it by delaying in-service and reactors

not in-service don't go into capability and capacity forecasts?

A. That's correct, yes.

Q. I guess I can't ask you about your engineering judgment in the forecast on that because that's just expressed as a possible six month delay and you are not putting any odds on it; is that fair, or are you putting any odds on it?

A. Well, judgment has been that there is about a 70 per cent chance of the impeller fix being successful.

Q. Now, Mr. Daly, I understand that the problems that arose at other reactors, Pickering and Bruce, I am thinking of problems like the fuel channel assemblies obviously, but the creep problems you had, the end joint problems, the bearing limitations, I forget all the acronyms, many of these problems weren't apparent until several years of operating had gone by; is that fair?

A. Some of them that's true. I referred earlier to 1983 failure of the Pickering pressure tube, and although we had anticipated changing pressure tubes, yes, it was a surprise to us that it happened in 1993.

Q. All right. In fact, since you

mentioned that, I was able to obtain a document which I would like to place before you. It will be no surprise, it will be nothing shocking to you. I apologize for not getting it to you sooner. It's entitled Ontario Hydro CANDU Operating Experience, and is Ontario Hydro NGD-9, 1985.

Mr. Chairman, perhaps this could be given a number.

THE REGISTRAR: 579, Mr. Chairman.

---EXHIBIT NO. 579: Document entitled Ontario Hydro CANDU Operating Experience, Ontario Hydro NGD-9, 1985.

MR. D. POCH: Q. Mr. Penn, I think it was you who said there was no way we could have envisaged the fuel channel problem, but I take it from the opening paragraph of this document, that is as early as 1958, and I quote:

> The lifetime of pressure tubes was expected to be at least 10 years and unlikely to achieve 30 years.

Is that your understanding?

MR. PENN: A. I think I said in evidence that the design basis of the -- in fact, my direct evidence was that there was an expectation of 15 years life of pressure tubes for Pickering "A".

Q. I will get into this in a moment, but

just looking further down, dimensional changes, again it was recognized in 1958 that there may be this lengthening growth of the tubes, I take it, as they absorb neutrons?

A. You are reading from the second last paragraph.

Q. Yes. And therefore some allowance was made to accommodate lengthening of pressure tubes?

A. Well, there was work done at Chalk River Nuclear Laboratories certainly in the late 50s, and it went on for probably another 10 or 15 years after that with regard to the behaviour of zircaloy or zirconium alloys under the influence of irradiation, and in particular the understanding of longitudinal growth.

Q. All right. So here we have, on one page, two examples of concerns or limitations that you were aware of from very early on, yet in your designs, in your expression of engineering, in your engineering response you weren't able, were you, to engineer your way out of these two problems? The pressure tube ruptured unexpectedly and you were faced with re-engineering at least at Bruce, I take it at Pickering 2, perhaps, Mr. Penn, you can help us, with respect to the pressure tube growth problem, the Bruce

West shift and so on?

A. I disagree with your position, because clearly we did make engineering adjustments for longitudinal growth. And it has been a statement of fact for many years that the life is limited, for example, on Bruce Unit 3 to 25 years for that reason. [10:25 a.m.]

But we changed the bearings, the bearing travel at the end of the channel, and, as you have just mentioned, we engineered a shift of those bearings at Bruce--

Q. And that required --

A. --known as the Bruce West shift.

Q. And that required time and delay or -- and downtime and money after you built the reactor?

A. Well, certainly it caused delay. I mean, it cost money, but --

Q. Let me just understand, that was for a problem which you foresaw before designing the reactor or before completing the design of the reactor?

A. We foresaw the process of zirconium elongating under irradiation, but in those early days there was insufficient knowledge. And experiments of course take a long time. You cannot simulate something

like that; you actually have to do the tests on the samples to determine what its growth rate is.

Q. Exactly. There are certain concerns which you are just going to have to wait and see about, and that one took -- well, how many years was it at Pickering? How old was Pickering Unit 2 when it suffered its accident in '83?

A. It was about 13 years.

Q. All right. And the oldest reactor you have on line now is...?

A. 21 years.

Q. 21 years. Now, just with respect to the incident at Pickering 2, I think it was Ms. Harvie at page 21292 who described this as the most serious event that has taken place in Ontario Hydro's reactor program, in asking you to comment on it in chief.

THE CHAIRMAN: What was that page number?

MR. D. POCH: I have the page reference as 21292. It would be the same volume

THE CHAIRMAN: That's probably volume... Let me see.

MR. D. POCH: I'm sorry. It's Volume 122, and that was at line 13.

Q. Mr. King, prior to this break, which I understand was a six-foot long break; is that right?

MR. KING: A. That sounds about right.

Q. All right. And they call it the G16. I take it that is because you have got on the matrix of tubes in the calandria it is tube G16?

A. That is right.

Q. Hydro had maintained that pressure tubes would always leak before they broke. Leak before break is the theory. And thus, any potential accident would be detectable in advance; is that fair?

A. There is a process where cracks get to a certain length and the through-wall cracks would leak before they get to what is called a critical crack length, which then they could -- the crack could grow rapidly in length, and the ability to detect a through-wall crack before it got to its critical crack length is referred to as the "leak before break" phenomena.

Q. Indeed, if you take out our second volume of materials, which has been given Exhibit 578, and I am going to ask you to look at page 134 there under Fracture Mechanics -- and this is a document which commences on page 129. It is dated March 2nd, '82. So this was just before the incident or the year before the incident?

THE CHAIRMAN: Just a moment. That is a

Hydro document?

MR. D. POCH: Yes, it is.

THE CHAIRMAN: And perhaps it should be given an exhibit number? Starting on page 129.

THE REGISTRAR: 129? That is 580, Mr. Chairman.

THE CHAIRMAN: Thank you.

---EXHIBIT NO. 580: A Review of Current Knowledge and Effects of Hydrogen on the Pressure Tubes of Ontario Hydro Operating Reactors.

MR. D. POCH: Q. And it is entitled A Review of Current Knowledge and Effects of Hydrogen on the Pressure Tubes of Ontario Hydro Operating Reactors.

And at page 134 of our material, section 3.12, Fracture Mechanics it reads, Concern:

> A pressure tube which develops a sufficiently severe flaw could fail at reactor operating pressure. The safety of the pressure tubes in CANDU pressurized heavy water reactors is based upon the "leak before break" criterion; that is, a small flaw would extend until it penetrated the wall and coolant leakage would be detected before the flaw reached the critical crack length and propagated unstably.

Did that in fact occur or did we have a propagation of a crack before it was detected?

MR. KING: A. Well, there are two considerations here: (1) Did it leak before it got for the point where the crack propagated unstably, and, if it did leak, whether it was detected. Leak before break, of course, is only valid phenomena with respect to detecting things as if you can detect it.

Q. You didn't detect it, though?

A. With respect to --

Q. Just let me interrupt, Mr. King. You didn't detect it?

THE CHAIRMAN: Mr. Poch, let him finish his answer.

MR. KING: With respect to the G16 incident I must admit I am not aware whether the detection in fact did occur. I have tried to get some reference to that in the last few days, but I have not been successful as of yet.

MR. D. POCH: Q. All right. So you say, it leaked before break, but your information is it wasn't detected so how do you know it leaked before break.

THE CHAIRMAN: No, no. He said he didn't know whether it was detected.

MR. KING: I have made some inquiries over the last couple of days to see whether the record shows whether there was any detection because the annulus gas system currently is such that the distance between the pressure tube and the calandria tube which is filled now with carbon dioxide gas, that is supplied and circulated and there are moisture detectors in the piping network that supplies this gas and there are alarms that ring if there is excessive moisture in this gas which would detect a pressure tube leak.

What I haven't been able to determine is whether there was any such indication on the G16 event.

MR. D. POCH: Q. Mr. King, if there had been such an indication wouldn't it have been expected that they have would have shut down the reactor?

MR. KING: A. That would be the normal course of action, yes.

Q. All right. So either there was no detection of a leak before break, so we don't know if there was a leak before break, or there was, you are telling me, in which case they didn't follow operating practices?

MR. PENN: A. I think maybe I can add something here, Mr. Poch.

I think you will recall that the

regulating system shut the reactor down promptly. There were no safety systems involved whatsoever.

While I can't confirm that the moisture indicators caused the operators to do that, I do know that it was done very promptly without any cause for concern and without involving any safety systems.

Q. Perhaps I am just working from memory here, Mr. Penn, I thought you had said, or Mr. King had said in his evidence in chief, the reactor was shut down manually.

MR. KING: A. It was shut down manually through the manual initiation of the reactor regulating system.

Q. Right. Someone shut it off.

A. After the failure, yes.

Q. After the failure and the crack had already gotten to six feet long.

A. Well, I'm sorry, the crack in the pressure tube, I believe which is 20 millimetres in extent -- six metres, I will accept that as an approximate distance for the length, but it was a very narrow crack.

The calandria tube held. There was no failure of the calandria tube, and as I mentioned in my evidence in chief, there is a small distance in the

bearings Mr. Penn was just referring to which allows for this elongation. There is a small tolerance there, and on the outside of those bearings is the bellows, the mechanical bellows that I referred to which failed. In fact, what limits the flow in that instance is the small tolerance at these bearings, fuel channel bearings, which limited the discharge into containment to a very small level.

Q. In fact, Mr. King, your words at page 21293 of Volume 122, line 13, was:

> "So there was a small leakage out of each end through the bellows onto the floor."

And you are confirming that now?

A. That's correct. But a flow rate is restricted by something, and it wasn't the leak in the pressure tube. It wasn't the hole in the bellows. It was the tolerance in the bearing which restricted the flow to a very small level.

Q. Right. And you refer to it as a small leak. Mr. King, how many tonnes of heavy water are there in the Pickering 2 heat transport, the primary cooling system?

A. Well, actually, the value I have right here is a value of heavy water per megawatt

electrical, so it is .268 megagrams -- sorry, metres cubed per megawatt electrical, so that would be a quarter of 540 --

Q. The information I had from just a conversation with Mr. Brian Thompson is 143 metric tonnes. Does that sound about right?

A. That is around 540 divide by four.

THE CHAIRMAN: Just a moment. What was the 140 - metric tonnes?

MR. D. POCH: 143 metric tonnes. All right.

Q. Perhaps you could just take that subject to check and it may be --

MR. KING: A. That sounds close.

Q. It's in the ballpark. And initially the leak would have been in the form of steam?

A. It would be a mixture of steam and water.

Q. I understand that initially you had to transfer heavy water from other reactors into Unit 2?

A. The way that the operator first detected the incident after the rupture was a lowering of the level of the D2O storage tank.

Normally, there is water being moved into

the heat transport system and coming out the heat transport system without any accident just as part of the normal process.

That water is being input through a set of pumps called the D2O feed pumps, and those pumps take source of water from the D2O storage tank. On lowering of the D2O storage tank level is what alerted the operator that he had a leak somewhere.

Q. Right.

A. The first course of action for an operator in that instance is after shutting down the reactor, of course, is try to maintain the level from the D2O storage tank, and there is a means of doing that by getting heavy water from other reactors or bulk storage in the plant.

Q. Now, Mr. King, at page 136 of Exhibit 578 is another Hydro document. It is a July, '84 document, Pressure Tube Failure Pickering NGS Unit 2, which provides a summary. Do you have that?

A. Yes, I do.

MR. D. POCH: Perhaps that could be given an exhibit, Mr. Chairman?

THE REGISTRAR: 581.

---EXHIBIT NO. 581: Hydro document, dated July, 1984, entitled Pressure Tube Failure Pickering NGS Unit 2.

MR. D. POCH: Q. All right. And from my reading of this document -- and I take this third page of the document under Event Description at the bottom, the leak rate was subsequently estimated to be approximately 17 kilograms a second?

[10:40 a.m.]

Can you confirm that?

MR. KING: A. Yes, I believe that was then equally distributed out of each end of the fuel channel, so the 17 would be a total for the initial leak rate.

Q. Right. The document indicates that over, I think, in the second paragraph on page 2 of that document, that is numbered page 2, it says one-and-a-half hours after the initial alarms, the situation was stabilized and at that point leaking was contained to a rate of 5 kilograms a second.

A. Yes, I see that.

Q. All right. And the leak wasn't stopped, I see at the bottom of page 2, until August 14th, two weeks later?

A. That's what it says in this document.

Q. All right. Just in that first 90 minutes when there was the higher leak rate, my calculation of 17 kilograms a second for 90 minutes is

about 92,000 kilograms of heavy water.

A. What have you multiplied?

Q. Ninety minutes times 60 seconds.

A. I can't see the reference to the 90 minutes.

Q. I thought we said an hour-and-a-half after the initial alarm, at that point the system was stabilized and the leak rate was -- water was being pumped back and the leak --

A. Sorry, I thought you did a calculation, 17 kilograms a second.

Q. Yes. And 17 kilograms was the initial leak rate in the period before stabilization.

A. But the leak of 17 kilograms a second did not exist for one-and-a-half hours.

Q. All right. So the leak rate was presumably between 17 kilograms a second and 5 kilograms a second?

A. That's correct. The leak rate depends on the driving force behind the hole which is of course the heat transport system pressure.

Q. My calculation was based on 17 kilograms a second and that got us up to the 92,000 kilograms, which was in excess of half the coolant water. So if it was only 5, or close to 5 it might be

a third of that; fair?

A. The importance in the loss of coolant accident analysis is not the total amount --

THE CHAIRMAN: Hold it. Before you go to that, which you certainly can, do you agree with what Mr. Poch just said, that the 5 kilograms per second would be roughly a third of his calculation, that that would be a reasonable - I can imagine these words - a reasonable estimate of what the weight of the water was?

MR. KING: So at 5 kilograms a second, that's 27 kilograms in 90 minutes.

MR. D. POCH: Q. That's 27,000?

MR. KING: A. 27,000.

Q. Kilograms.

A. That's the low, that's the smallest it could be. And you had a value of what? You had --

Q. 143,000 tonnes.

A. So are you talking metric tonnes?

Q. I am sorry, 143 tonnes, not 143,000 tonnes.

A. You are talking metric tonnes?

A. Yes.

Q. Yes. So 143,000 kilograms, just so we are in comparable units. 27,000 versus 143,000; is

that...

A. So you had the total volume in the Pickering "A" heat transport system, I recall, as 144 metres cubed; is that correct?

Q. Well, I had it in tonnes. 143 metric tonnes. I thought we were dealing in weights here, we can keep it simple.

A. I guess it's approximate, a metric tonne I believe is a metre cubed.

Q. Isn't a tonne 1,000 kilograms? A metric tonne is 1,000 kilograms?

A. Yes, but we were dealing with metres cubed before.

Q. I thought we were dealing with 5 kilograms a second or 17 kilograms a second.

A. You had a value of 144--

Q. 143 tonnes.

A. --Metres.

Q. No, it was tonnes. All in weight. Let's stay in weight and not complicate the matter.

A. The value I gave you for the amount of water was metric cubed, but that's approximately equal to a metric tonne.

Q. Yes. So we have 146 metric tonnes in the heat transport system, is that it? And then you

have calculated a range of between, what, 27,000, and if it was at the high rate the whole period of time, which would not be the case, it would be 3 and a bit times that.

Q. All right.

A. 80 or something. 80,000. So somewhere between 27,000 and 80,000 kilograms a second.

Q. Kilograms over period?

A. Kilograms total.

Q. So in other words, in comparable units you have 146 metric tonnes of coolant and you lost somewhere between 27 and 80 or 90 of those metric tonnes in that first 90-minute period?

A. That sounds about right.

I was about to explain why, the significance of that.

It's really the rate that you lose coolant which is important in loss of coolant calculations in the analysis.

The fact of the matter is that during this whole incident the heat transport system itself was never deficient in heavy water, because while this water was being lost it was being picked up off the floor by a system called the D2O recovery system, put back to the suction of your D2O feed pumps and pumped

right back into the heat transport system.

So there was never any point in time where there was anywhere between this calculation of 27 to 90 metric tonnes, there was never any time when that amount of water was on the floor. It may have gone out and then it was put right back in again.

Q. Mr. King, you agree that in a serious accident perhaps externally initiated where a number of problems occur at once, loss of coolant, loss of cooling capability, the amount of water you lose would be very important, the rate of flow out, if you didn't have a capability to keep replenishing, that would be very important; would it not?

A. We are into other event right now.

Q. Pardon me?

A. We are into a another event, we are not talking about G16 anymore.

Q. I am just listening. You have described the G16 event as involving a small leak, and I want to see if this small leak occurred in another sequence where you didn't have your cooling capability, would that be a small leak or would that be a leak of some significant consequence?

A. If we did not have a capability to bring in water -- to take this water off the floor, as

I described it?

Q. To bring in any cooling water. If you didn't have any way to replenish the cooling system.

A. If you want to keep on failing systems, what happens if this system failed and the next backup system failed and the next backup system failed, yes, there is some point in time when you are going to come to the point where you don't have anymore ways of getting water into the core.

Q. And indeed, if you are successful at shutting down a reactor, it's not cold to the touch at that point, is it? Fuel is still producing some percentage of its heat output for some period of time?

A. There is decay heat. I am not sure what part of the system you are touching.

Q. If you shut down a reactor, if you successfully shutdown a reactor and you had no way of cooling the fuel, would it melt?

Can you answer my question? You can give your explanation after. Can you answer my question?

A. There is a very long explanation. I am just hesitating about how long I should get into it, because I have a feeling you don't want the long explanation.

Q. I don't. I have heard your concern that there are a great many systems and you don't worry about that ever coming to pass. But if it came to pass, the fact that you have shut down the chain reaction doesn't mean there is no concern about melting; right?

A. In the various accident analyses that we do, melting of fuel following the loss of coolant accidents that we are talking right now would not occur.

There are a couple of very specific flow channel blockage event -- a flow channel blockage event, which is analyzed in the Darlington safety report where there is a small degree of fuel melting in one channel.

Q. But in your analysis you are concluding that there is some cooling mechanism, and I am saying if you don't have a cool mechanism --

A. So you are talking about non-design basis accidents beyond what we analyze?

Q. My concerns aren't limited by what you have analyzed. I am concerned with the physics of the situation.

Simple question. Chain reaction is stopped, you don't have any cooling mechanism, you tell

me it's a non-design basis so that is fine, in that scenario you could have melting, you would have melting you; true?

A. If you have a source of heat and if you say that heat does not get removed, then the laws of nature would say that that would melt. But it is just improper to view things in that simplified a manner.

Q. Well, in your view it's improper.

In fact, we will get to this later, but you have assumed that your various systems or mechanisms will come into play and that's why you don't analyze that?

A. Well, we analyze all sorts of systems failures, but as I mentioned there is a point in time where if you want to get far, far out on the probability spectrum, you can get to a worse accident than that which is within our analyses that we do normally.

Q. We will come back to that, it's really a separate topic. It's was just an aside to in what context this a small leak and in what context it could matter.

Now, I understand that certain technical changes were made to counter the problems thought to be

responsible for the Pickering tube rupture, and you said, Mr. King, there was also a big inspection program, is my recollection correct, as a result?

A. As a result of the G16 event, in my evidence in chief I indicated that that initiated several programs, one of them being an enhanced inspection program.

Q. But three years later through a different sequence in a reactor that was shut down, you suffered a pressure tube rupture at Bruce Unit 2, March '86; is that right?

A. That's correct.

Q. And, Mr. King, I understand that the dynamics of that accident were very different, there was different temperature gradients, different pressure gradients, and so on. But the problem was a sudden rupture and it involved hydriding, did it not, the same metallurgical hydriding that was present in Pickering?

A. I believe that incident initiated around the rolled joint area and there was a manufacturing defect, I think, involved in that, but I think hydriding was a mechanism, yes.

Q. But your inspections didn't pick up that particular problem, it was different enough in kind that you hadn't caught it at that point in time?

A. I would guess that's correct. Perhaps somebody else on the panel may want to offer some other insight into it.

MR. PENN: A. I would like to confirm that it was a manufacturing defect.

It was so minor in size that during shutdown we decided to try and find this by pressurizing the system and that's what caused the failure. It was a process of trying to discover where it was, because it was so small. It had nothing whatsoever to do with the G16 event in Pickering Unit 2.

Q. But, Mr. Penn, when it went, because you pressurized this reactor that was otherwise unpressurized, when it went it went so suddenly that it didn't just crack the pressure tube, the calandria tube was ruptured as well; is that right?

MR. KING: A. If I could answer that. Yes, it did. But as you noted, the reactor was shut down at that time. If I could just back up a bit. [10:55 a.m.]

As Mr. Penn mentioned, there was an indication of a leak through a leak before break mechanism on that channel. The operators had shut down the reactor and were looking at it from acoustical

emission techniques. They were trying to listen to the channels to see, through some electronic techniques, to see which channel in fact had the leak.

What they were unaware of, though, is that there were some policies, which perhaps hadn't been adequately passed on to the operators, is that they shouldn't have been in a high pressure. They were pressurized up to about 8 megapascals at a cold condition. They were down around 40 degrees C, I believe, approximate number.

Q. Human errors category?

A. And what happens is that when the pressure tube fails it hits the calandria tube not with a steam, a low-momentum type of impact, but it hits it with water, which is much denser, and it was really that type of impact which failed the calandria tube. That calandria tube had not have failed if the reactor would have been at power with a hot heat transport system.

Q. This matter is referred to in a document from Hydro which appears in again our second Volume, Exhibit 578, towards the very end, page 151. It is entitled Nuclear Integrity Review Committee, Annual Report for 1986, and it is dated August, '87. This is an Ontario Hydro publication, Mr. King;

correct?

A. That's correct.

MR. D. POCH: Mr. Lucas, perhaps we could get a number for that?

THE REGISTRAR: 582.

---EXHIBIT NO. 582: Ontario Hydro publication in Exhibit 578, page 151, entitled Nuclear Integrity Review Committee, Annual Report for 1986, dated August, 1987.

MR. D. POCH: Q. And if you turn over to page 153, if you can see at the top where partway through Description, it is referring to channel NO6. That is this same event?

MR. KING: A. That's correct.

Q. It said that:

> Resultant water hammer loads generated in the annulus caused the failure of the associated calandria tube. Six fuel bundles were also severely damaged.

I take it that the people conducting the test hadn't anticipated anything quite that violent?

A. No. As I mentioned, they were not aware of the fact that this test should not be conducted with the heat transfer system in a cold condition.

Q. Now, you have said this is a

manufacturing problem. This is the newer alloy of tubes; this wasn't the same alloy. This is the new generation of zirconium tubes, the kind that we have at Darlington and are envisaged for future plants?

MR. PENN: A. Yes, it was, but that has nothing to do with the overlap defect.

Q. And, Mr. King or Mr. Penn, do you believe that Hydro has now solved all the problems that have been encountered with fuel channel assemblies?

A. We believe that we have extensive knowledge of the mechanism that failed G16. We have conducted tests on ring samples of every pressure tube taken out of Pickering Unit 3 and a large number taken out of Pickering Unit 2 and 1, and we will also be taking more samples out when we retube Pickering 4. We have just done it.

I think I can clearly state that while we can never be certain that we have solved every problem that we have a great deal of knowledge of that subject.

Q. Mr. Penn, I am wondering if you can turn with me to - Mr. King, this may be for you - again in our second volume of materials 578, page 1. This is a document from the Atomic Energy Control Board. It is a Memorandum to the Board Members from their Directorate of Analysis and Assessment regarding CANDU

pressure tubes.

Perhaps this should also receive a number.

THE REGISTRAR: 583.

---EXHIBIT NO. 583: Document from Atomic Energy Control Board, Memorandum to Board Members from their Directorate of Analysis and Assessment regarding CANDU pressure tubes.

MR. D. POCH: Q. And this document dates from October of 1990. Have you seen this document before, Mr. King?

MR. KING: A. Well, I have seen it since it is in your exhibit.

Q. I would like to read you a few of their comments and you can perhaps tell us whether you agree.

Page 2, third paragraph:

> Most CANDU reactors are operating now with some of their pressure tubes in contact with their calandria tubes. Where contact occurs and blisters subsequently form, the risk of a failure originating from sites of contact with blisters increases. This form of degradation is likely to precede problems associated with loss of ductility or

fracture toughness arising from irradiation damage and hydrogen ingress.

And at the bottom of that page talking about -- the last sentence there:

> This type of behaviour appears to have been a precursor of the unstable failure of a pressure tube that occurred in Pickering Unit 2 in August, 1983. None of the reactors in service now employs zircaloy-2 as a pressure tube material. The material in use is zirconium-2-1/2 per cent by weight niobium. Thus far, there has been no evidence of contact blister formation in-service in tubes of the latter material.
>
> Industry specialists do acknowledge, however, that blisters could form in fuel channels where there is pressure tube to calandria tube contact and where hydrogen concentrations in the pressure tube are high.

And down in the second last paragraph on that page I read:

> Based on measurements of hydrogen contact in pressure tube material

obtained from samples over the past few years, industry specialists have predicted that some pressure tubes in-service may have already developed contact blisters. Proven non-destructive examination techniques are not able to detect the presence of blisters in pressure tubes.

And it goes on to give us some good news and some bad news at the bottom paragraph:

Recent data also appears to suggest that in general the degradation rate is slow. Previous concerns about acceleration in degradation rate arose because of high hydrogen level indications obtained in repeat sampling work. These high readings are now believed to have resulted because of errors in the analysis of some samples.

It should be noted, however, that there remains some confirmed evidence of high hydrogen levels in a few pressure tubes. These results are at variance with recent data and cannot be easily reconciled with a perception that

degradation rates remain consistently low.

Mr. King, is that still the understanding at this time?

A. I believe this document, as you have noted, is an AECB document of approximately a year and a half ago.

My understanding, while I am not directly involved, is that the fitness for service guidelines which they are referring to in here have been developed, there has been lot of work on them in the last year-and-a-half in conjunction with the AECB, and they are satisfied with these fitness for service guidelines that we have.

Now, perhaps Mr. Penn can add something, but that is my understanding of the situation.

MR. PENN: A. Well, I would like to add sufficient to put this document into perspective.

First of all, it was advice by AECB staff to their board with regard to a decision on allowing Pickering 4 to restart and operate for about nine months before it was shut down to retube it. That is a very prudent thing for a regulator to do to be sure that there would not be any problem with that reactor.

The second thing I would like to comment

is that while we don't have means of detecting blisters if you had read other paragraphs you would have noted that we do have excellent ability to even detect the smallest crack in a blister.

In fact, that type of work has been very important in leading to the criteria that Mr. King mentioned.

And the last thing I would like to say, unless you want to get into more detail, is that the Mr. Waddington who wrote this document to his board, he ends up at the very end of this document by saying, "The new evidence is encouraging." And what he is referring to is the understanding of the takeup of hydrogen and deuterium and zircaloy alloys, the rate at which it occurs, and the knowledge of formation of blisters, et cetera.

THE CHAIRMAN: Sorry to interrupt, but where does it say "The new evidence is encouraging"?

MR. PENN: The last sentence, Mr. Chairman, on page 4.

THE CHAIRMAN: Oh, I see it now. Thank you. Thank you. I'm sorry to interrupt.

MR. DALY: I think it is also important to add that the AECB were satisfied that Pickering Unit 4 could be returned to service, it was returned to

service and ran with no pressure tube problems until the shutdown in August.

MR. D. POCH: Q. This was seven years after the Pickering accident, and I take it this was about reactors with the new kind of zirconium?

MR. DALY: A. Correct.

Q. And just so we can reach agreement on this, I take it that discussion then is how long or how -- well, in fact, if we read the views of AECB staff, item 2:

> Pressure tubes must be removed from service well short of conditions which could lead to such an event.

That is what this is the focus on, and the question was whether or not we had reached that point with Pickering...4, was it?

A. Pickering 4, yes. And that is the whole purpose of our inspection and maintenance and sampling program, to make sure we do remove them from service well before that type of condition.

Q. And what you are saying is, Mr. Penn, if I understood you correctly, you are confident now that you will be able to detect a leak before a break, and that is one reason why you are not worried about this?

MR. PENN: A. I don't think I actually said that, but I can certainly comment on it.

What I said was we are now confident that we understand the mechanism and the rate at which hydrogen and deuterium is absorbed within zirconium alloys. In fact, it has been very clearly shown that this rate of uptake is very slow and that it is continuous but it is very slow, and there is no acceleration in that rate over the period of time.

Now, as far as confidence of detecting a leak before break, we have spent a great deal of time improving annular gas systems to do just that, and I can't say with 100 per cent certainty that we would pick up every one, but I do know that we have extremely good systems to detect that sort of problem.

Furthermore, we have criteria, given that we know the channels that do have contact with the calandria tubes in our reactors -- and by the way, I would disagree that not all reactors have contact. Since we do know which channels they are we regularly inspect them, and we have a program, an agreed program with the Atomic Energy Control Board to do just that.

Q. Let's be clear, Mr. Penn. You are not disagreeing with me; you are disagreeing with the observation of the AECB staff there?

A. I was commenting on the first part that you read out from this document on page 2, and it does start with the sentence, "Most CANDU reactors..." And I am just confirming that the "B" reactors, for example, we know there is no contact.

MR. KING: A. I would just like to add something on the ability to detect cracks before they rupture in pressure tubes.

We all recognize and all have said that G16 incident was a surprise.

Subsequent or during all the retubing of the Pickering reactors a lot more importance at the same time was placed on the annulus gas system, and during all the retubing exercises the annulus gas system was verified, all the flow paths were verified as open, extra instrumentation was put in on all of the plants, and those systems right now, we have a fairly high degree of confidence that in fact they are functioning as detection mechanisms for leakers.

Q. All right. Mr. King, I am interested in your comments as they pertain to the particular problem here which you think you have a handle on.

But isn't this a case where from the outset you knew there was a potential problem? Hydro documents we have spoken of this morning say: Safety

of pressure tubes rely on a leak before break. You were relying on that, and yet your evidence this morning was the first indication that they had a leak was a lowering of the storage water. They didn't catch the leak before break in time.

Maybe if that same accident happens again you are telling me we would now catch it?

A. I think my evidence earlier on this morning was that I cannot confirm that there was a demonstration of leak before break at G16.

Q. Well, whether there was or there wasn't, if there was they didn't catch it in time to shut the reactor off before it propagated into a larger crack?

A. It was the indication of lowering storage tank level which initiated the shutdown of the reactor, that is correct.

Q. So your engineering vision and your safety analysis while it didn't lead to a big meltdown your engineering vision was wrong about something where you knew there was a potential problem?

A. The safety -- I forget what paragraph. It was in the document dealing --

Q. The 1982 document from Ontario Hydro?

A. Correct, Exhibit 580, that paragraph

where they were referring to the safety of the pressure tubes. That is what there are talking about there. There are talking about the safety of the pressure tube; there are not talking about the safety of the plant. So I think that is an important distinction.

Q. Mr. King, can you answer my question? Your engineering vision failed you at that time?

A. The engineering vision which I assume you are referring to is the reference in this document, Exhibit 580, which is published in '82.

Q. Yes. And your vision at the time that you constructed these reactors in light of the knowledge that you had then. You banked on a scenario and it didn't go as you predicted?

A. Again, you have got to distinguish between your safety of pressure tubes and the safety of the plant.

We have not set ourselves up from a world safety design point of view to be -- there is no need to be perfect. It is this setting up the strawman of perfection and then saying, well, you haven't met it; therefore, the plant is unsafe.

In my evidence in chief referring to the defence and depth approaches to safety design, yes, there can be occurrences where you have failures,

whether they are failures in equipment or failures in oversight of some mechanism --

[11:15 a.m.]

Q. Or failures in your understanding of the phenomenon or engineering?

A. Or failures in some understanding of some phenomena.

Q. And this was one of those?

A. Well, I think we have all agreed that the G16 event was a surprise.

MR. PENN: A. I think I would like to say something about this engineering wisdom that you have spoken to, Mr. Poch, and I refer to Exhibit 581,

Q. I'm sorry, I have lost the page for that.

A. That's on your page 138.

Q. Yes.

A. And under Event Description, 3.0, it starts:

> Prior to the event, Unit 2 had operated continuously for 342 days. At 1983 August 1st the unit was operating normally producing 515 megawatts net. At 1110 hours alarms in the control room indicated a sudden leak of heavy water

from the heat transport system.

And then further down in the last paragraph:

> Manual reactor power reduction, cool down and depressurization were initiated by operator action with the normal process control systems.

The vision we had of course was to recognize that you could have a failure in a pressure tube and to have systems that would alarm the operator to know it had happened. And I think that indicates the importance of the nature of vision in safety related matters.

Q. I don't want to go into too much detail of how you analyze that safety, but I promise you, Mr. King, we will come back to that question in a little while.

Could we turn up page 21 of the first volume, 577. This is a document entitled Reliability of CANDU Nuclear Generation, Ontario Hydro's Demand/Supply Plan, prepared by Peter Fraser, Adviser, Nuclear Power Electricity Section, March 8, 1991.

Mr. Daly, I am assuming you have seen this document before I gave it to you last week.

MR. DALY: A. I had, just shortly before

that, but yes, I had.

THE CHAIRMAN: I am sorry, is this an Ontario Hydro document?

MR. D. POCH: I was going to elicit that from the witness.

Q. Mr. Daly, could you tell us who Peter Fraser is and whose document...

MR. DALY: A. I don't know he works for currently, but I believe at this time he was an adviser in one of the ministries, I believe the Ministry of Energy.

THE CHAIRMAN: Of Ontario?

MR. DALY: Of Ontario, yes.

MR. D. POCH: Q. So this is a document he produced in that role?

MR. DALY: A. Yes. There is no indication from this who he provided it to or in what sense it was used, but he was an adviser in the nuclear power electricity section of the Ministry of Energy.

Q. And just before we identify that, at page 36 is a briefing note version of this, titled Ministry of Energy Briefing Note, Division Policy Development Coordination, title, Major Nuclear Generating Station Outages. On the page 44 of our exhibit it indicates it is prepared by Peter Fraser,

February 26th, '91, Backup Brian Findlay.

Is Mr. Findlay also familiar to you?

A. Yes, I have met Mr. Findlay on a couple of occasions.

Q. And he as well works in the ministry, the Ministry of Energy?

A. Sorry.

Q. He works in the Ministry of Energy as well?

A. I believe so, yes.

Q. And he is a nuclear adviser and has been for some years there?

A. My only contact with him was through ONCI and he participated as an observer for some of the ONCI hearings, that's really my only knowledge of Mr. Findlay

Q. And Mr. Penn or Mr. King, Mr. Fraser in fact had assisted Dr. Hare in the ONSR effort; is that correct?

MR. PENN: A. Yes.

MR. D. POCH: So perhaps then these documents could be given an exhibit number before we get into them.

THE CHAIRMAN: Are there two documents, Mr. Poch?

MR. D. POCH: There are technically two documents and perhaps for ease of reference they should get separate numbers, the first one commences on page 21. The first commences on page 21, it's entitled: Reliability of CANDU Nuclear Generation.

THE REGISTRAR: 584.

MR. D. POCH: The second document commencing at page 366 of our exhibit is entitled Major Nuclear Generation Station Outages.

THE REGISTRAR: 585.

---EXHIBIT NO. 584: Document entitled: Reliability of CANDU Nuclear Generation.

---EXHIBIT NO. 585: Document entitled: Major Nuclear Generation Station Outages.

MR. D. POCH: Q. I would like to refer to the first one.

At page 4 of that document, we have a little bit of history, Mr. Daly, I am wondering if we can agree on some of that. It refers there to Energy Probe Komanoff study. Komanoff is the gentleman who has authored Exhibit 563, which is the Coalition's evidence on this question? You are familiar with Mr. Komanoff's work?

MR. DALY: A. Yes, I am.

Q. And there Mr. Fraser notes that Energy Probe has noticed the decline in nuclear

performance and last year brought it to the attention of the Ontario Energy Board, and hired Mr. Komanoff to see if there was a correlation of the capability factor with plant age.

The Hydro response to that is highlighted in the second last paragraph on that page:

> Hydro staff suggested that a detailed engineering analysis would be a more insightful means of identifying the contributing factors to aging and whether they are expected to recur.

And Mr. Fraser comments:

> Although this argument is attractive, it is important to remember that a decline in performance comes about in part because you don't know exactly what will go wrong.

Leaving aside Mr. Fraser's last observation, that was the debate at the time; fair?

A. That was part of the debate.

I think as I mentioned yesterday, Mr. Komanoff focuses on trends associated with aging, and from our point of view we want to understand what is behind the aging so we want to get at those systems which are contributing to incapability, and in fact

spend a lot of time tracking the history of the different systems. So we try to get behind the general term aging and understand the causes for it. So in that sense it was a bit of a difference, yes.

Q. In fact, the Energy Board at that time did not make a projection itself or adopt a projection based on Mr. Komanoff's piece. In fact, this is recited at the second paragraph on page 26. Perhaps I will read it in so we are altogether here.

> Using their study Energy Probe argued before the OEB that nuclear energy production would be 2.2 terawatthours lower than Hydro estimated because of aging related incapability. In 1989 the Board did not accept the Komanoff study as an adequate basis for a rate adjustment because it was based on numerous extrapolations and assumptions which had not been tested during the hearing.
>
> Mr. Fraser goes on to note:
>
> In fact, energy production from nuclear generation fell by 2.2 terawatthours in 1989, consistent with Energy Probe's prediction. Hydro

forecast in ONCI that its 1989 average capability factor would equal 76 per cent. The actual '89 average capability factor was 74.5 per cent.

Is that your understanding, Mr. Daly?

THE CHAIRMAN: What was his understanding?

MR. D. POCH: Q. The forecasts, what the competing forecasts were and what the reality turned out to be?

MR. DALY: A. That is correct, yes.

Q. And it goes on:

> Energy Probe updated Komanoff's analysis at the OEB hearings held in 1990 by including the 1989 data. They estimate the rate of decline attributable to age at .97 per cent per year... And there is statistical significance data given. ...in 1990 the capability factor declined 11 per cent, a much larger decline than would have been predicted.

I take it, Mr. Daly, first of all those facts are correct, can you confirm that?

A. Yes, I can confirm those facts, yes.

Q. And in fact, Hydro was predicting

higher performance than Mr. Komanoff and I think it was as Mr. Adams who updated Mr. Komanoff's study for Energy Probe at that time?

A. My recollection was that in 1990 we were slightly -- both Mr. Komanoff's predictions and our own predictions for 1990 were significantly off. As I described earlier, 1990 was a particularly bad year, we did have a number of planned and unplanned outages, and most of the forecasts done for that year were significantly off.

Q. They go on to note, Mr. Fraser goes on to note:

> Unlike the previous year, the Ontario Energy Board concluded that Ontario Hydro's forecasts of nuclear performance were overly optimistic. They recommended that the type of analysis used by Komanoff be developed by Ontario Hydro for baseline forecasts of nuclear production.

Do you recall that, Mr. Daly?

A. Yes. I would like to make two comments on that.

We had also concluded at the same time that our forecasts of performance were overly

optimistic, and during the last two or three years we have been cutting back the forecasts of production primarily from the "A" plants, and I did indicate that in my direct evidence.

As you, I think, pointed out yesterday, they are some significant differences between the original DSP and the Update, reflecting that we have cut back in our forecast production substantially from the "A" plants.

So basically we agreed with the OEB's conclusions and have taken corrective action.

On the second point they recommended the type of analyses used by Komanoff be developed by Ontario Hydro. We reviewed that ourselves, we felt that the regression analyses used by Mr. Komanoff was a useful short-term check but useful only as a short-term check.

We have, since that time, started to develop the probabilistic model we talked about yesterday, and we intend to fully develop that and use that as one of our checks for future forecasting.

Q. Mr. Daly, you are suggesting then that a regression analysis which takes account of general trends as opposed to looking at specific factors, although Mr. Komanoff does of course account

for some of the specific engineering forecasts you are making and segregate those out, we will let Mr. Komanoff explain his analysis some other time, but are you suggesting that the regression analysis of trends is actually better for short-term analysis than for long-term?

A. That was our view of it. If you extrapolate -- I guess the analysis Mr. Komanoff originally presented were basically just a straight line through your best fit to your history and a straight line extrapolation, and we felt that while that's a useful check, if you sort of do a best fit of your last five to ten years, that's a reasonable check what might happen in the next one or two years, but if you start extrapolating that out for the next 10 or 20 years, its credibility is very questionable. So we felt there was really no value to the long-term linear projections that Mr. Komanoff was tabling at that time.

Q. He doesn't in fact have a -- you have seen his current study, I take it?

A. I noticed one curve in his current study which is in fact not a straight line, it's a parabola. But he does in his study, he gives two ranges, for the long-term he has a range where he assumes a parabola and then he has another factor

calculated where he adjusts the age-related degradation.

Q. That's where he says if you are able to somehow limit it to 1 per cent, he just simply does the math for you and says what you would get.

A. That's right. And it makes a huge difference.

Q. Yes, of course.

And in fact, his current study which again we will get to, but just so it will be in context when we get there, it's not a linear model; it's a complex curve with a number of variables?

A. That's right. And at this point in time we just have the curve. We don't have much of the detailed information behind it.

Q. I am sure we will have an opportunity to provide that to you in time for your counsel to question Mr. Komanoff.

I take it, though, that Mr. Komanoff's earlier projections have been better predictors of Ontario Hydro's performance since he made those projections throughout the period than your own have been?

A. Well, we have already talked about the figures for 1989 and 1990. My understanding is our

'91 prediction was slightly better than the one tabled by Energy Probe at last year's hearings, that is my understanding from --

Q. That would have been Mr. Adams?

A. Yes, that's my understanding from Mr. Adams.

I think the predictions were not actually far apart.

Q. All right. Do I take it from your comments a few moments ago that you are then not intending to conform to the requests to the OEB to do a regression analysis of the type that Mr. Komanoff does to develop a baseline forecast?

A. Not exactly, we don't plan to do exactly the type of work that Mr. Komanoff has done for the reasons I have described.

We carry out some checks which I think are essentially similar by looking at history and extrapolating from history.

So in our view we make some checks on our forecasting that are similar on a short-term basis to those done by Mr. Komanoff, but as I indicated earlier, we prefer not to use the general aging term; we prefer to get the systems that are causing the incapability.

So we have adopted basically I think a

similar approach in terms of short-term checks and we are developing this, in response to the OEB we are developing this probabilistic model which we intend to use to assist us in long-term forecasting.

MR. D. POCH: Mr. Chairman, that's a convenient place to break for me.

THE CHAIRMAN: All right, we can break for 15 minutes.

THE REGISTRAR: Please come to order. This hearing will recess for 15 minutes.

---Recess at 11:35 a.m.

---On resuming at 11:55 a.m.

THE REGISTRAR: Please come to order. This hearing is again in session. Be seated, please.

THE CHAIRMAN: Mr. Poch?

MR. D. POCH: Thank you, Mr. Chairman.

Q. Mr. Daly, when we left off you were just drawing this distinction between Mr. Komanoff's approach, which takes account of certain specific systems and then looks for a general aging phenomenon, and your approach where you do it all on the specific system basis; correct?

MR. DALY: A. That is the basis of the probabilistic model we are developing, and on our existing forecasting process we also look at the trends

on all systems.

Q. All right. Now, Mr. Heintzman spent some time with you discussing the relationship between OM&A or preventive maintenance, which presumably would be part of OM&A, and performance.

Can we turn to page 24 of 577, which is the third page of Exhibit 584? Mr. Fraser reports there:

> As noted above, the retubing outages were excluded from the curves--

and he is talking about Mr. Komanoff's curves, I take it.

> --so that planned-for outages would not distort the trends. It is worth noting that go Ontario Hydro has used its retubing outages to install new safety equipment and to repair broken components that are difficult to access during ordinary outages.
>
> In other words, the retubing outage is an overhaul of the nuclear reactor.

And then goes on to say:

> Ontario Hydro expects reactors once retubed to attain excellent performance levels. Hydro stated in 1989 before the

OEB that it expects Pickering 1 and 2, the retubed reactors, to average 15 per cent incapability factor between now until the end of life.

Which would be, I take it, 85 per cent capability factor, Mr. Daly?

A. That's correct, yes.

Q. All right. Can you confirm that in fact you do take advantage of the downtime of retubing to do some difficult jobs and some preventive maintenance and to try to catch up on that kind of work?

A. We do, and we did some of that to some extent during the Pickering retubing outages. We have a more substantial program planned for the Bruce "A" retubing outages.

I am not sure my exact quote was that we expected the reactors to average 15 per cent incapability. Certainly, that is our target, as I indicated before.

Q. All right. And just so we can be a little more precise about that, I will go over your head with your permission to Mr. Niitenberg's comments.

If you turn up page 48A of this volume?

Now, this is a transcript from the Energy

Board's HR 15 hearing, that would have been 1986. I assume it is electricity rates proposed for 1987.

Can you first of all identify for us who Mr. Niitenberg is?

A. He is the Senior Executive Vice-President of Operations. His title has changed had a few times, but he is basically our No. 2 man.

Q. Right. And I just wanted to read with you a couple of his comments from that era to see how good his vision was.

Well, first of all, perhaps, Mr. Chairman, we should make this transcript excerpt an exhibit in these proceedings.

THE CHAIRMAN: Right. Next number?

THE REGISTRAR: What page is that, please?

MR. D. POCH: At page 48A.

THE REGISTRAR: 48A?

MR. D. POCH: "A".

THE REGISTRAR: That will be 586, Mr. Chairman.

---EXHIBIT NO. 586: 48A of Exhibit 577, being an excerpt from the Ontario Energy Board's HR 15 hearing, 1986.

MR. D. POCH: Q. And if you turn to page 48E. First of all, Mr. Daly, you can confirm that this

was in the context of a discussion about OM&A dollars. You can see that on the preceding page around line 17 and following.

At the top of page 48E there is a comment:

> When we get the units back I would expect those units to perform in the first few years after they come back better than average.

And he elaborates further at page 48G, two pages on:

> Could I just make one last attempt to try to clarify this. Even if Pickering 1 and 2 is left out of the calculation the DAFOR deteriorated up until 1985. By putting additional OM&A effort in, excluding Pickering 1 and 2, we expect to make an improvement and we can do a number of things.

So I take it there, Mr. Daly, I am interpreting Mr. Niitenberg's comments the same way you would, that he is saying: We are going to do more OM&A, that will help with performance. And, in particular, he said earlier on: We are going to do OM&A on these Pickering retubing reactors, and we would expect better than average performance when we bring

them back on line because of that?

Is that a fair interpretation, or do you take the same meaning from his comments?

MR. DALY: A. That is a fair interpretation. We did expect them to perform better than average, and, in fact, currently they are operating slightly better than our current average.

Q. Right. And you spoke of a two- to three-year lag, is my recollection, in your discussion with Mr. Heintzman about how fast you would expect to see a performance change as a result of an OM&A change.

A. Yes. The indications we have from the modelling we have done is that we would expect a time lag of that sort of order.

Q. So we would expect, then, that it would certainly be soon enough to see the effect of this increased OM&A that was done during the retubing and is talked about here in 1986, now in 1990 or 1992 if we look at, for example, 1990 or so?

A. Well, the first unit was returned from retubing in 1987, and the second in 1988, and the third just last August, so we are just beginning to get to the point in time where we should be able to see that improvement.

We certainly did not see as much

improvement as we had hoped for from Pickering 1 and 2 in the early years. We have made a few changes to the work we did on Unit 3 during its rehabilitation and have had slightly better performance from Pickering 3. So we are continuing to learn from our experience on the work we do during a retubing.

So we have got those units up to 75 per cent at the moment, and we plan to get them higher.

Q. Perhaps you could turn with me, then, to Mr. Komanoff's study which has been given Exhibit -- I believe it's 563, Performance Reliability of Ontario Hydro CANDU Plants?

THE REGISTRAR: That is correct.

MR. D. POCH: Thank you, Mr. Lucas.

Q. Now, I turn to this study simply because Mr. Komanoff presents in one place a whole lot of data in the appendix that he used, the raw data and the various factors he considered, which is Appendix 2 of that piece.

By the way, Mr. Daly, this may be of some assistance to you. This is the data you were hoping you could get to see what is behind his analysis, so it is provided in the appendix, and, as I say, if you need any other information we will be happy to provide it.

Let's see if we can interpret this data

correctly. First of all, the sources are provided, but I take it -- I don't know if you have had an opportunity to check all the numbers. I wouldn't expect you would have.

Can we take the numbers, subject to check?

MR. DALY: A. There are some slight differences. I haven't checked all the numbers. There are some slight differences. He appears to drift between capability factor and capacity factor in a few places. The differences in most cases are small.

Q. All right. And if you could just follow me, then, the seventh column from the left, first there is the number, then the unit, then the -- I'm sorry, I may have counted wrong. In any event, the column headed Year that would just be the calendar year? And if we go five columns farther over we see CBFAC.

Now, do you recognize those numbers as being the representative of the capability factors at the various units in the various years listed?

A. Yes, they are representative of. As I say, we notice a few minor differences, but they are certainly representative of, yes.

Q. Perhaps we will have you provide any

amendments to that in advance of Mr. Komanoff's attendance so we can attune this to your numbers.

If you go down to line 13, which is a Pickering 1 line for the year --

THE CHAIRMAN: Which Pickering 1 line?

MR. D. POCH: Mr. Chairman, the lines are numbered in the first column.

THE CHAIRMAN: But what number, though?

MR. D. POCH: I am looking at 13 lines down.

THE CHAIRMAN: You are looking at 13, Pickering 1?

MR. D. POCH: Pickering 1. Yes.

THE CHAIRMAN: All right.

MR. D. POCH: Q. Mr. Daly, so we are sure we all understand this, this would then be, if we went over to the CBFAC number, this would be the capability factor you experienced for Pickering 1 in the year 1984? Do you see that?

MR. DALY: A. Yes.

THE CHAIRMAN: That is zero; is that right?

MR. DALY: Yes, that was during --

THE CHAIRMAN: Is that right?

MR. D. POCH: Yes.

MR. DALY: During retubing.

MR. D. POCH: Q. Of course. And we see three years in a row with zero, '84, '85 and '86, and those were the retubing years, the years when you were out completely for the whole year for retubing?

MR. DALY: A. Correct.

Q. Correct? And then the following year, '87, below, we see 19.11. So that would be a year where you got back in-service towards the end of the year?

A. Correct.

Q. From that is my interpretation correct that the subsequent years starting in '88 would be full years unaffected by retubing outage for that particular unit?

A. That's correct.

Q. All right.

A. I'm not sure whether you have the full 1991 figures available or not.

Q. All right. Yes, that's correct. I think you jogged my memory. These are the three-quarter year results you had available at the time you did this study?

A. Yes, I think so.

Q. And they were, of course, prorated to

be expectations of full year based on three-quarters of a year.

If we just drop down to line 33 we see in Pickering 2 a similar sequence, Pickering 2 being the first one that was retubed, there were four years with zeros from line 33 down to line 36 for the years '84 to '87. That corresponds with your understanding?

A. Of retubing, yes.

Q. Yes. And then, again, most of the next year in '88, hence the 14 --

A. Yes. I would just like to make one comment on that 14.3 there. That reflects the capability factor for the whole year.

Where we talk about capability factor following retubing, we start with the date that the unit was returned to service on the system. So in fact, the 14 per cent for the whole year, the actual figure post-retubing would typically be around the 75/80 per cent level for the two months that it operated in that year.

Q. That is helpful. And indeed, to avoid that problem, though, if we just look at the next three years, or indeed, if we include that estimate of what the full year would be given the 14 for the partial year, we see the numbers in the subsequent

years, and I just took the next three which were full years to avoid that very problem you highlight, 75, 76 and 78; that averaged about 73 per cent. Sound about right?

A. Yes. We have actually calculated the exact figure from the point in time when the unit was returned to the system to the end of January this year, and it was 73.8.

Q. Now, in fact, that accords with Mr. Fraser's understanding at page 22 of our exhibit, and I am reading from the second last paragraph in the middle:

> These units were expected to perform at an average of 83 per cent between now and their retirement. In 1989 these units performed at 73 per cent.

Now, he is combining different units and looking at one year there, but we are in the same ballpark?

A. In 1989, yes.

Q. Yes. All right. And let me just ask you, you may not be able to tell me this and we will leave it for Panel 10 if that is the case.

If you have a 10 per cent variation in annual capacity factor it is not linear with avoided cost, is it?

THE CHAIRMAN: We are talking about capability factor now, not capacity factor?

MR. D. POCH: Yes, we are talking about capability factor of -- let's keep to capability factor. That's fine.

Q. We have a 10 per cent variation from the expected lifetime capability factor. It is a complex relationship with avoided cost, I take it?

MR. DALY: A. I would refer you to the ONCI sensitivity of the LUEC, the LUEC to the capacity factor. I think we discussed that yesterday, and I indicated a couple of interrogatories to you, 9.30.2 and .30.3.

Q. Just so we are on the same wave length here. I in fact had looked at 9.30.2. I think that was given an exhibit number already, and it shows the LUEC for 20 per cent incapability and 30 per cent incapability and those numbers are in 89 cents per kilowatthour: 3.08 and 3.47. So I saw a greater than 10 per cent difference in LUEC. LUEC went up by more than 10 per cent for a 10 per cent change in capability or incapability.

And that accords with your understanding, too?

A. Yes. My understanding is that it is

not quite a linear relationship and that if you check that curve in ONCI it will show the relationship.

Q. And if we look at the Pickering 1 numbers in Mr. Komanoff's Appendix 2, I see for the four full years following retubing starting in '88 through '91 we have 89.1, 72.6, 68.6 and 60.86.

Do you have a final number by the way or a better number for 1991 for the full year? Is it approximately that?

A. I don't have a figure off hand. I have an average figure for Pickering 1 from the point in time that it was returned to service after retubing until the end of January, '92, and that figure for Pickering 1 is 75 per cent.

Q. Right.

A. So that is comparable to the 73.8 per cent I gave you for Pickering 2, which was the first unit to be returned to service.

Q. I was actually more interested in this trend. You would agree with me, I take it, that there has been a steady decline in Pickering 1 performance since the time of retubing. In that fourth full year it is down to 60. I was interested in that trend. Do you see a trend there, first of all? Do you agree with me?

A. Well, there are a couple of factors I would like to point out about 1990 in particular.

One, on Pickering there was a planned inspection of the vacuum building so all eight Pickering units were down for about a month, and that is an inspection we only carry out once every 10 years. So in that sense it was a little unusual.

The second factor was we had some problems with fuel handling systems, deratings due to fueling machines, which is related to OM&A, I think it is a good example of that. So we did have some deratings in '91 attributable to fuel handling incapability, and that was significantly corrected in '91.

Q. Well, Mr. Daly, what I am really looking at here is that there is a pattern of declining performance, and I am sure there are a number of explanations, particular events that caused that, and it seems to be extending certainly three, if not four years past that time when you took advantage of retubing to do all this preventive maintenance. It is into your lag, post-lag period, and we don't seem to see a dramatic upswing in performance. Would you agree with that?

A. Certainly there hasn't been a

dramatic upswing in performance. The overall average for each of the three units since they returned to service has been 75 per cent, and as we learn from our experience on Pickering 1 and 2 we applied that experience to Pickering 3. Pickering 3 since its return to retube has averaged 83 per cent.

So you will see from the three figures I have given you that --

THE CHAIRMAN: I'm sorry, what is that for Pickering 3.

MR. DALY: 83 per cent since August of last year.

[12:15 p.m.]

So you can see from the figures that I have given you, the performance gets slightly better as we gain more experience.

MR. D. POCH: Q. I'm sorry, Mr. Daly, how long has Pickering 3 been back on line now?

MR. DALY: A. Since August of last year.

Q. So the number you have gave us was --

A. About seven months.

Q. Seven months. And indeed that was what we saw with Pickering 2, it came in strong and went down from there?

A. There were some declines, yes.

Q. So can we say from this, Mr. Daly, that more OM&A cannot guarantee high performance?

A. It certainly can't guarantee it. We feel there is a fairly strong correlation between the two, certainly a correlation between the two. First you need the funds and then you have to apply them to the right things. There are many other factors that contribute to good performance, but OM&A is certainly one.

Q. Could you turn with me to page 49 of our first book of materials, Exhibit 577. This is a single page from Exhibit 585 -- 583. I correct myself once more, 483. This was a document that Mr. Argue of my group produced taking the numbers from the Update to see how the Update compared to Plan 15.

I am really just interested in the capacity factor numbers, the latter, the right-hand box and graph below which of course are derived from the combination of capacity and energy. And if you look at the bottom, the upper line is Plan 15 and we noted that there had been in Plan 15 a somewhat declining trend in capacity factor.

Whether or not you are prepared to agree it's a statistically decline -- you will agree with me that there is just visually there is a general decline

there?

A. I think one factor you would have to look at would be the timing of retubings. Retubings can affect the profile quite significantly. So you can appear to be seeing a decline in particular years but in fact it is just the period of retubing. So you would really have to identify the time periods of all the retubings on both curves.

Q. And would you agree the lower curve represents the current forecast for your system capacity factor, nuclear capacity factor in the Update?

A. I haven't checked all the numbers exactly, Mr. Poch.

The general trend, the general corrections we have made, certainly that provides an appropriate picture.

THE CHAIRMAN: What you mean is planned retubing, is that you are what you are saying?

MR. DALY: Planned retubings, yes.

MR. D. POCH: Q. So, can I take it then that your explanation for this change in pattern is that you have shifted retubing dates, you have brought them in earlier, lowering the front end?

MR. DALY: A. No, I didn't mean to leave that impression.

When I was talking about the retubing dates you seemed to be indicating you felt that the top of curve, the original DSP, was showing a generally downward trend, and I think you may have been influenced there by the years, sort of 2004 to 2009, and I know there are some retubings planned for that period.

So getting back to your original question?

Q. I guess I was just looking for an understanding of the very general shift in the pattern from a slightly declining one to what appears to be a slightly increasing.

A. I think the reason for the general shifts in the pattern are that we have recognized that over the last few years we have overestimated the production from the "A" plants in particular, and we have made those corrections to reflect what we feel are more appropriate values for the "A" plants.

But the "A" plants are going through a period of -- or Pickering has almost completed its period of retubing and rehabilitation; Bruce "A" will be going through its equivalent period starting in '94. The "B" plants are already operating well. So the curve reflects a combination of all those factors.

It's getting beyond the retubing rehabilitation period. It's recognizing that we have a nuclear hiring program in place, we have got more staff, more dollars, we have learned from previous experience, we have got a quality improvement process recently established.

So there are always a number of factors driving the forecast in the downward direction, but equally there is a number of factors driving the forecast in the upward direction, and that's our current best judgment of the combination of those factors.

Q. Just to get a sense, you have explained how you have lowered the projections for the "A" units, but in indeed, if we look on this same page in the middle box under energy, there Mr. Argue had simply deducted the numbers in your Update from the numbers in your Plan 15, and as you can see in almost every year there is more energy expected from your nuclear system, I think in every year, in the Update than the plan.

Indeed at the bottom it's summed and it is 217 odd terawatthours. To my eye that's about the equivalent of twice the amount of power you will get from your entire nuclear system in any given year in the 90s, over that period of time. So your actually

showing, in your Update you are actually showing an overall improvement in your expectation of nuclear energy generation than in the Plan 15?

A. Sorry, I don't follow you there.

THE CHAIRMAN: I don't understand that. Are you looking at the energy chart?

MR. D. POCH: Yes.

THE CHAIRMAN: The figures in Plan 15 are invariably higher than the Update figures.

MR. D. POCH: I have read the double negative wrong. You are absolutely right, Mr. Chairman. Thank you.

Q. So then the conclusion is just the opposite, overall you are expecting to see a drop in nuclear energy performance for the combined existing system over that period of 217, that accords with your understanding?

MR. DALY: A. Yes, that's consistent with the fact of capacity factor charts, and of course the original DSP would have had additional nuclear units starting at 2003.

Q. Now, Mr. Daly, have I understood your argument correctly, woven through all your comments is a --

THE CHAIRMAN: He wasn't giving argument;

he is giving evidence.

MR. D. POCH: Q. Then take my second wording, woven through your comments, you are expecting better performance out of future plants than the combined experience of your present system and, indeed, that parallels your expectation for the host "A" stations as compared to the "A" stations, and have I understood correctly, that's because you believe you have designed out problems?

MR. DALY: A. Well, our combined experience to date is about 74, 75 per cent. And as you rightly say, within that the "B"stations have a performance in the sort of the 85 per cent range. So our predictions of future plants are based on our experience to date, our knowledge of what is happening with the "B" plants and some allowance for not just design improvements, we would expect to make design improvements in future plants but we would also expect to be able to ever construct them better, to commission them better and to operate them better based on our learning over the last -- well, it will be almost 30 to 40 years from the start of our program until any new plant could be built.

Q. Mr. Daly, in fact, the "B" reactors, most are under nine years old?

A. That's correct, yes. They would average around eight years probably.

Q. And if you look at Mr. Komanoff's analysis, as I am sure you have, you see this as page 5 of his analysis, section D, this is Exhibit 563, he likens reactors to athletes.

A. Sorry, could I have the page number again?

Q. Page 5.

A. Right.

Q. And it is paragraph D, he talks about the different offsetting effects and likens in that paragraph:

> CANDUs are no different from professional athletes or industrial workers and U.S. nuclear power plants, all of which on average improve over time until reaching a peak and decline thereafter.

And he goes on to indicate that his analysis says:

> To date Hydro's CANDUs have been reaching their peak in the 9th or 10th year, though the exact point has varied for individual units, and has also been

subject to the influence of the first three factors noted above.

Interestingly, U.S. reactors also peak around age 9 or 10 on average as indicated in comprehensive statistical analysis of U.S. nuclear plant performance by KEA.

And that's Komanoff Energy Associates.

So Mr. Daly, if Mr. Komanoff is right, of course we wouldn't be able to test this on the "B" plants yet, would we?

A. We would be able to make a projection on the "B" plants and we would have to make a judgment on that projection.

Q. And if you go to --

A. I'm sorry, perhaps I could add to that. In making that judgment about the "B" stations and future stations capability, I think there are some factors that you can make a pretty good judgment on. For example, some of the design changes that have been made to pressure tubes, for example, putting the four garter springs in as opposed to the two garter spring design which lead to problems; improving the construction techniques for putting the pressure tubes in place in the first instance.

You don't totally rely on design, you can look at specific design changes, operating changes, commissioning changes made in coming to that assessment.

Q. All right. By the way, Point Lepreau has yet to be retubed?

A. Correct.

Q. If you just look in the second volume, 578, at page 90.

A. Sorry, I didn't catch the page number.

Q. Page 90. This is a report in the Telegraph Journal, Thursday March 21, 1991, about Lepreau. I don't know how much of this you can confirm for us, but it indicates that Lepreau could be, in the first column, it could be shut down for up to two years?

A. Well, a typical retubing outage would take approximately two years. As you have seen, Pickering 3 was retubed in 26 months and we expect to be Pickering 4 in 19 months and Point Lepreau would be approximately the same size as Pickering.

Q. Right. And it goes on to indicate what some costs are there. In the top of the second column it sums the costs as a half a billion dollars

associated with retubing and replacement power. Does that conform to your estimate of what one unit --

A. I can't confirm any of the Point Lepreau.

Q. I was thinking from your own experience.

A. Well, we have provided the Pickering and Bruce retubing costs and these values are, I guess, of the same sort of...

I guess one perhaps difference between ourselves and Point Lepreau, we would share our costs, so we are able to share our costs over four or eight units. Point Lepreau, would be able to share some costs probably with us on some equipment but I would think it would be fairly small.

Q. And, Mr. Penn, I notice in the fourth column there the columnist is speculating on the impact this is going to have for the consideration of a second unit at Point Lepreau, and he says:

> While the proposed plant would be a different type from Lepreau 1...

He goes on.

I just caught that clause and was wondering, are you familiar enough to comment on the Lepreau 2 proposal in general?

MR. PENN: A. Only in as far as New Brunswick has been considering new generation and has looked at several options, including fossil fuel.

Q. All right. And Lepreau 2 would be a CANDU 6?

A. Well, I believe that New Brunswick Power Commission from my general knowledge has considered a CANDU 3 and a CANDU 6 at one time or another.

Q. Fine. So you can't tell me if that comment was referring to changes to the CANDU 6 from the vintage that Lepreau 1 was or some other design?

A. I would think that comment is speculation of the columnist. I don't know what basis it might be on.

Q. That's all I am really asking, if you have any better information.

A. No.

MR. D. POCH: Mr. Chairman, I don't know if that should be made an exhibit, although Mr. Daly was able to agree with some of the facts there, perhaps it could be identified.

THE CHAIRMAN: I think it is practical valueless, so we can mark it as an exhibit if you like just for the purposes of the records.

MR. D. POCH: Yes, I am just using it to ask Mr. Daly for his understanding.

THE CHAIRMAN: Okay. Give it a number.

THE REGISTRAR: 587.

---EXHIBIT NO. 587: Excerpt from Telegraph Journal, Thursday, March 2, 1991.

THE CHAIRMAN: It would be easier to ask Mr. Daly about what he knows, if anything, about what has been going on, without necessarily putting in all the editorial comment that's in this newspaper article.

MR. D. POCH: Thank you, Mr. Chairman.

Q. Mr. Daly, so the obviously then the capability and capacity factor, I think they are capacity factors that Mr. Heintzman put to you for Lepreau, were in a pre-retubing -- a time before retubing?

MR. DALY: A. Yes, we were talking of historical experience, yes.

Q. Now, Mr. Daly, I think you agreed a fuel moments ago in your list of reasons why you would expect to do better in subsequent reactors, that one of the list then was designing out problems that you were aware of?

A. Correct, yes.

Q. I take it that the same logic could

be applied to maintenance, you can maintain better, you could target your maintenance at problems that you have already experienced.

[12:35 p.m.]

A. That is right. You learn from your experience basically in all phases.

Q. Now, would you agree with me as a matter of logic that the effectiveness of that strategy will depend on how big the universe of potential problems is, how many of the potential problems have surfaced?

A. Yes, with some qualifications. We expect there are going to be some surprises. I mean, although we have engineering judgment in all these things we don't preclude surprises. We expect surprises. So we design, commission, operate, anticipating there will be some surprises. So we are not precluding some surprises.

Q. Mr. Penn, I think you can confirm that even a minor change of the same basic design, but the change for example we saw in the piping and sizing at Darlington, can create some unexpected surprises?

MR. PENN: A. Well, I think that example points to a surprise.

Q. All right. You don't have to have a

complete redesign to get into surprises; even small changes can have unexpected effects?

A. Well, yes. But, of course, probably for the few surprises we get we get thousands of circumstances that are successful.

Q. Sure. And you are not able to freeze the design for no other reason than the regulator is going to continue to ask for changes, small or large; is that fair?

A. Well, certainly, the regulator will always be looking for new knowledge, and if it involves safety systems then we may have to change. It depends on what the nature of the subject is and whether you could modify an existing design or change its operation slightly. Again, it is a question that I can't really answer.

Q. Just so we get an idea of the form this takes without getting into details of the specifics. Could you turn with me to page 11 of 578, our second set of materials?

This is a study which was attached to Exhibit 9.2.97. I don't believe it is an exhibit yet.

THE REGISTRAR: Just a minute. That will become .78, 520.78.

---EXHIBIT NO. 520.78: Attachment to Exhibit 9.2.97.

MR. D. POCH: Q. Excuse me for one moment. I will find the reference in it.

Yes, the reference I was looking for appears at page 60 of our materials, page 45 of that document.

MR. PENN: A. Yes?

Q. I just want to see if this is an example. It reads: An approach -- this is in the bottom section, 4.2.18, Assessment of Containment Concepts:

> An approach has been developed to address AECB concerns regarding the steam generators penetrating the containment boundary of the square containment design.

Now, a long discussion then ensues, and we can maybe talk about the particular concern or lack of concern in it, but, Mr. Penn, if it turns out to be or turned out to be a valid concern that is the kind of problem that where the regulator says, after the fact, gee, maybe this isn't the optimum design. And that in that particular example if they asked you to move the steam generator into containment completely as opposed to - I take it it is half in and half out - that would be a significant change; would it not?

A. Well, before I answer that, I would like the Panel to understand that this is a progress report of our schedule and cost reduction study, and this study is, if you like, the conceptual engineering of a potential new 4 by 881 nuclear station. And during that phase we address the issues that will allow us to reduce the schedule of cost.

One of the issues during the conceptual phase, of course, is to satisfy the regulator that the basic design is acceptable to them. So what we are referring here to is that the Atomic Energy Control Board asked that before the final approval of a new nuclear station that they would want to have us submit a document comparing different forms of containment, which we did.

Q. All right. So there was --

A. So if I --

Q. Sorry, Mr. Penn. Go ahead.

A. If I may, Mr. Poch? Again, your comment is quite a speculative one because we haven't determined whether it is necessary or unnecessary.

Q. Mr. Penn --

A. You can postulate anything you like and say it will add cost or uncertainty, and I would agree with that.

Q. I didn't postulate this, Mr. Penn. The AECB asked you to consider this issue. They didn't do that just to create work for you, did they?

A. The AECB asked us to review the different forms of containment, and if the regulator is doing its job that is a very appropriate thing to ask us.

Q. Mr. Penn, they didn't ask you that before you built Darlington; they asked you to reconsider this question, the Darlington containment versus other designs, and this is post the Darlington construction, the bulk of Darlington construction. It is with respect to future plant.

They don't create work for you for no reason. There obviously is a concern. It refers there to AECB concerns, does it not?

A. That is what it says. I repeat again, the AECB asked Hydro to review different containment systems, and it so happens that the square containment system, part of the steam generator shell, is also part of the containment boundary.

Q. So, Mr. Penn, you said to me this is a hypothetical concern. Are you saying that the AECB's concern is just unfounded?

A. I don't think I mentioned the word

hypothetical at all.

Q. Or speculative, I don't recall the exact words you used. You commented something to that effect.

But let me ask you squarely: Do you think the AECB's concern was totally unwarranted and a make work project, or do you think they had some basis for that.

A. Well, of course not. I was trying to answer your question where you said, I believe, something about the outcome of this study and what its impact would be on costs.

Now, I would have to go back to the transaction to understand what your question was.

Q. Indeed, I was trying to use this as an example. If it turned out, and I put it in the hypothetical --

A. Well, that is what I was referring to.

Q. All right. And if it turns out that the AECB's concern was well founded, that would lead to a design change, putting steam generation inside containment, that would have significant impacts; fair?

A. Yes. And then we would have to deal with the issue whatever the circumstances were.

Q. Just to bring this back to the discussion about performance, when changes such as that occur in your design that introduces new variables, new uncertainties; fair?

A. When and if it happens, yes.

Q. Yes. That was the only point I am trying to make here. Now -- excuse me.

All right. Perhaps you could turn with me to Mr. Fraser's study, page 28 of our exhibit. I just wanted to run quickly through this list. This is a list of factors that Mr. Fraser indicates have come to light that since the DSP was written it will adversely affect capability factors.

THE CHAIRMAN: I'm sorry, 28, Volume 1, is it?

MR. D. POCH: Yes.

THE CHAIRMAN: I'm sorry, I thought we were in the same document.

MR. D. POCH: I'm sorry, Mr. Chairman. It is Volume 1, the volume is 577, the particular document is 584. Page 28 of ours; page 7 of his.

THE CHAIRMAN: And this is Mr. Fraser of the Energy Department; is that right?

MR. D. POCH: Of the Ministry of Energy, yes.

THE CHAIRMAN: All right.

MR. D. POCH: Q. I just wanted to get your comments on some of these quickly.

You mentioned sagging calandria tubes affecting shutdown system 2, and it affects Bruce "A", Bruce "B" and Darlington. He says:

> It is not clear whether these outages, which he indicates would be three months, for each unit have been included in the DSP as they are not explicitly mentioned.

I didn't hear that in your review of the problems at Darlington. Is that still a concern?

MR. PENN: A. Well, the issue arose with regard to Bruce "A" that due to the weight of fuel in the fuel channels that there is a tendency of sagging of the calandria tubes towards nozzles of the liquid injection system.

In my knowledge, our Nuclear Engineering Department have reviewed various ways of coping with that during retubing, and, as I understand it, that it is possible to support the calandria tubes while the pressure tube is removed.

So at this point in time it is not clear that we have to remove both pressure tube and calandria tube to correct this problem.

Q. Perhaps --

A. It is an unresolved issue, I would have to say.

Q. From your comments I take it you are referring to a problem that arises during retubing because --

A. No, it just happens over the course of time--

Q. All right.

A. --and due to irradiation and due to weight.

Q. So this is a problem where if you delay retubing, say you wait until year 30 for Darlington, it is more likely to become a problem with time? Have I understood correctly?

A. Well, it slowly occurs with time.

MR. DALY: A. I might add that one of the things we are doing this year is carrying out some measurements on one of those units to determine just what the amount of sag is and how much clearance there is. So that will help us with our future plans.

Q. Right. And if you learn that it is happening at a rate such that it is unacceptable before year 30 then you would presumably either address this problem before year 30 or accelerate the retubing

schedule?

A. It would depend on the fix. There are a number of potential fixes to this problem, as I understand it, some of which could be done during routine planned outages.

Q. The second one is steam generator problems, and I think you have covered that already in your evidence.

The third one is environmental qualification, and there he indicates that the AECB had asked Hydro for assurance that the equipment at the Pickering and Bruce stations is environmentally qualified; that is, it will operate when needed in accident conditions, and new reactor equipment is designed to be environmentally qualified. The equipment in the "A" stations has not been tested for this.

First of all, can that be right; you actually had safety systems and they hadn't been tested to see if they would work in accident conditions?

MR. KING: A. I don't think that statement is fully accurate, no.

Q. So can you just help me then, Mr. King, what is the environmental qualification about?

A. Just that one sentence you are

talking about, the equipment in the "A" stations has not been tested, that sentence right there.

Environmental qualification is a process where you gain assurance that the equipment will operate in a certain environment. That assurance can be obtained by testing that equipment in the environment, separating it from the environment, putting an enclosure around it such that it doesn't see the environment, by taking a component and putting it in a test chamber and putting it through its environment, or just through some analysis of stresses and conditions that component would see to qualify.

So there is a whole range of options. Testing is only one of the range of options.

Q. Can you just --

A. But as this paragraph refers to, there is a program currently going on, currently initiated, in Ontario Hydro to come up with a more comprehensive environmental qualification program which will provide added insurance, come up with a huge data base for all the components in the plant to assist future maintenance and replacement of components to make sure that they are replaced with the same degree of qualification that they have right now, and that we have been discussing with the Control Board that

progress on that program. That is as it is stated in this paragraph.

Q. I guess I confess to being a bit confused, then. Had you or had you not actually tested these components, these safety systems, to see if they would operate in accident conditions?

A. As I said, I believe what Mr. Fraser was referring to is...we use the word "testing environmental qualification" is where you take a component, a valve, you put it in a test chamber, you put a steam water environment and you cycle it a few times in the environment and you see that it can work.

Q. Had you done that?

A. I think he is talking about testing.

Q. Had you done that?

A. Okay. Now, what I indicated was that testing is only one way of providing environmental qualification.

Q. Right. Had you done that?

A. We have done some other things other than testing.

Q. So you haven't done that kind of testing?

A. No, because I am saying that there is other ways. You can put the pump inside a room inside

the containment building such that it does not see the environment. That is another way of qualifying it.

[12:55 p.m.]

Q. All right. And have you done that?

A. Well, the thing is, there is a mixture of components and --

Q. I am trying to understand. Mr. King, it's very simple here. They are saying they want you to do something which apparently they feel you haven't done, and it is going to cost you hundreds of millions of dollars. I am trying to understand what it is you hadn't done that they want you to do.

A. The whole subject of environmental qualification over the last 20 years, the state-of-the-art, the expectation of the regulatory body with respect to how you qualify it, what codes you qualify it to, has an increased over that period of time. The current expectation level is reflective of what we have done in Darlington. We are now saying, okay, well, we have got the current state-of-the-art of environmental qualification at Darlington, let's go back and have a look at our existing stations.

Q. I think I understand now. What this is about then is not seeing if the safety systems would perform in accident conditions conceived of and spec'ed

at the time of Pickering "A" was built, but rather to see if they can perform to the new safety specifications, the current ones, which presumably Darlington, as you have indicated, Darlington has been built to be; is that right?

A. No, I don't think that's accurate.

It's the Pickering safety report, that goes through various accidents, analyzes those accidents, takes credit for various systems to mitigate the consequences of those accidents, and it's a matter of providing an increased level of assurance which is consistent with today's expectation in the environmental qualification area.

I took it that you were referring to new regulations as being in a broad sense. I prefer to call it a new level of expectation, because there is no new, there is no knew environmental qualification regulation which has just been issued by the Control Board with is behind this issue.

Q. So what has changed then is not the safety criteria for Pickering, but rather the criteria for evaluating your confidence in meeting those safety --

A. That's closer to the case.

Q. And just to do that, there is a

figure there of 324 million. Is that the current figure?

A. Right now there is an approved program, preliminary engineering phase, it was approved last December, I believe, for $93 million, one of the purposes of that program is to come up with a definitive cost estimate for the final program.

Other things it will do is it will look at approximately 50 per cent of all the components in the "A" and "B" stations, excluding Darlington, and in order to get the knowledge base to come up with that definitive cost estimate.

So, the cost estimate here of 300 in Mr. Fraser's article of 324, I am not sure where that came from.

Q. In fact, one final item perhaps before we break, turn to page 117 of Exhibit 577. This may help you. This is report from Nucleonics Week, I take it that is a trade publication, Mr. King?

A. That's a weekly periodical issued by McGraw Hill on the nuclear industry.

Q. December 12th. And there is report there Outages, AECB Upgrade Demands to Drive up Hydro Costs in '92, that quotes the vice-president Elgin Horton, Hydro vice-president Elgin Horton as saying it

could cost up to 790 million -- could add up to 790 million to nuclear cost in the 90s. And then he goes on in the next paragraph, Horton was commenting on a Ministry of Energy report made public, and it goes on, which refers to the $325 million, and his quote is:

> "I don't know where they got that figure," Horton said. "We estimate that environmental qualification program we will be asking our board to approve will cost $770-$790-million in as-spent dollars over the next 10 years.
>
> "However, there is a very large potential for change in the figure over that time period. We don't know how much safety-related equipment in older plants will have to be replaced or how much may pass inspection five or six years from now."

Is that a range that you are comfortable with?

A. As I indicated, what we asked our board of directors for in December of 1991 was for $93 million. I have seen the figure of, the round figure of $700 million mentioned, but I believe that is a established as some upper bound figure. My discussions

with people familiar with the program indicated that it's that sort of figure, an upper bound figure.

Q. Perhaps in the next while could you just check with someone to see if that's the current understanding, the figures that are attributed to Mr. Horton there are correct or if it's an upper bound. Would that be simple for you to verify?

A. As I indicated, I think I just said that that figure has been mentioned. It's not what we asked the Board to approve, as it suggests in this sentence here, and I think it is an upper bound.

Q. All right. That is fine, you will let me know if you hear otherwise, will you?

A. I will.

MR. D. POCH: Mr. Chairman, that's a convenient place to break.

THE CHAIRMAN: All right. We will adjourn now until 2:30.

THE REGISTRAR: The hearing will adjourn until 2:30.

---Luncheon recess at 1:03 p.m.

---On resuming at 2:30 p.m.

THE REGISTRAR: Please come to order. This hearing is again in session. Be seated, please.

THE CHAIRMAN: Mr. Poch?

MR. D. POCH: Thank you, Mr. Chairman.

Q. We have been talking about performance and the differences between your projections and those, for example, of Mr. Komanoff.

Could we turn up Mr. Fraser's comments. I want to talk a moment with you about the implications of performance. Mr. Fraser's comments, which appear in Exhibit 585, the second of his two reports, this is at page 36 of our first Volume 577.

Mr. Daly, at the bottom of that first page highlighted you will see his conclusion that the main implications - and this was particularly for 1990 where you have given evidence it was a particularly low year for nuclear performance - one of the implications was that secondary sales - by that I take it he means exports - would virtually eliminated, and Hydro made up the difference with additional purchases, and I take it that could be, we could call that word "imports", in order to supply the anticipated demand and meet acid gas emission limits. Hydro purchased 13.8 terawatthours of power in 1990.

Again, can I ask you to confirm his view is consistent with yours?

MR. DALY: A. Certainly the sales were virtually eliminated in 1990 and we did make up the

difference with additional purchases. We were faced with tight acid gas emission limits and continue to be. The purchases, we purchased 13 terawatthours outside Ontario and purchased, my recollection is .6 inside Ontario. So I think the final figure was 13.6, but it's substantially the same.

Q. Mr. Johansen, when you tally up emissions attributable to different technologies, I take it you don't attribute to nuclear the emissions associated with coal you burn in a backup mode when nuclear doesn't perform to expectations.

MR. JOHANSEN: A. Well, that sort of calculation would be done by the system planners. But to my knowledge that would not be part of the forecast.

Q. Further, Mr. Johansen, with respect to this question of whether meeting regulations is the object, and the question of impacts, residual impacts, if I can call it that, assuming you meet regulations, this reliance on imports, the emissions associated with the power you import, that's not counted in your assessment of whether or not you meet regulations; is it?

A. Well, I guess I would have to say that that is a subject that Dr. Effer during Panel 8 probably addressed. I can't say for sure, but --

Q. Do you know the answer?

A. No, I am not certain about that.

Q. Well, indeed, if this is correct, the description we just read, it's precisely because of the emission cap that you turn to imports.

And, Mr. Daly, those imports are predominantly coal-fired.

MR. DALY: A. They are certainly a large amount of coal-fired.

Q. So, Mr. Johansen, can we take it from that that the cap, the regulatory limit, doesn't capture these kind of emissions that come to be because of nuclear performance below expectations.

MR. JOHANSEN: A. Emissions arising from--

Q. Purchases.

A. --utilities other than Ontario Hydro?

Q. Yes.

A. That's my general understanding, yes.

Q. Now, Mr. Penn, Ontario Hydro is a member of the Canadian Nuclear Association?

MR. PENN: A. Yes.

Q. And you pay dues and participate in that organization?

A. I believe so,

Q. I take it AECL would be another major participant in CNA?

A. I am sure they would, yes.

Q. And could you turn to page 50 of our material, the first volume. There is a recent ad there from the Canadian Nuclear Association, which you have indicated you are member of, which talks about acid rain and greenhouse effect and makes the statement that nuclear reactors do not produce these two emissions, and I think that statement is--

A. I think it is factually correct.

Q. --factually correct.

Is it your position, though, that - and is it the CNA's position, I am not sure if you are sufficiently familiar with the organization to which you belong but perhaps you can hazard that comment too - is it your position at least that nuclear is a reliable way to avoid CO(2) and acid gas emissions?

A. Well, the very fact that they don't produce them I suppose means it's reliable in not producing them.

Q. I am thinking of approaching this in the context of the discussion I just had with Mr. Johansen and Mr. Daly, that the shortfall in nuclear performance recently led to purchases of coal-fired

power.

A. Certainly it led to some of it. I don't know whether we had other units that weren't producing. Well, I do know that Lakeview is being rehabilitated.

Q. Could you look at page 51?

Mr. Chairman, this is a report entitled Time Lost: Report of the Subcommittee on Acid Rain of the Standing Committee on Fisheries and Forestries of the Federal Parliament. It is from the 1983/84 sittings.

First of all, perhaps we could get an exhibit number for this report.

THE REGISTRAR: 588.

THE CHAIRMAN: Thank you.

---EXHIBIT NO. 588: Time Lost: Report of the Subcommittee on Acid Rain of the Standing Committee on Fisheries and Forestries of the Federal Parliament, 1983/84.

MR. D. POCH: Q. Now, I am not sure, Mr. Penn, Mr. Daly or Mr. Johansen, which of you were on the scene in '84 when this occurred, but do you recall that at the time there was a debate within -- or there were plans, I should say, being formulated in the corporation for dealing with acid gas abatement, these limits we have just spoken of, and that this body

looked at Hydro's plans specifically?

MR. PENN: A. I'm sorry, I don't know whether they did or not.

The article, which I haven't seen before, or the committee report, certainly has a chapter with regard to Ontario Hydro. I don't know whether they consulted with Ontario Hydro, if that's what you are asking.

Q. Let me just read a few highlights here and get your comments if you can accept the logic of their position. It starts:

> In June of '83 officials from Ontario Hydro testified before the subcommittee in the Ottawa.
>
> Then we have highlighted some sections.
>
> The subcommittee's concern about future emissions lies squarely with Ontario Hydro's strategy for combating acid gas emissions.
>
> The bulk of acid gas control is to come about through the substitution of nuclear generating capacity for coal-fired generating capacity.
>
> And then, a number of events starting in the summer of '83 - which is at the

bottom - have led the subcommittee to question the feasibility of the strategy. The recent shutdown of nuclear generating capacity at Pickering has led to a greater reliance on coal generation.

If CANDU performance over the past year is indicative of future reliability, Ontario Hydro's ability to meet its limits for '86 in 1990 must be seriously in question.

And of course we just heard evidence about what happened in 1990.

The only obvious alternative for Ontario Hydro is to increase the use of coal generation in the event of serious and unanticipated shutdowns of nuclear generating capacity.

In fact, the subcommittee has very little confidence in the stated projections and acid rain strategies of Ontario Hydro.

Over the past four years, Ontario Hydro has routinely modified its projections for both acid gas emissions and electricity demand. It has also

significantly advised its acid rain abatement strategy over this period. What is missing from this continuously shifting equation is a concrete program of SO(2) and NOx control is immune from the vagaries of consumer demand and unscheduled failures of CANDU nuclear units. The subcommittee feels that Ontario Hydro's stated acid rain control strategies is imprecise and undependable.

Mr. Penn, would you agree that reliance on nuclear power as a future option compared to an option which is more reliable in terms of unexpected outages carries with it this risk that you will then fall back on coal and emit acid gas and indeed carbon dioxide?

A. Well, I think that's a speculative question.

The fact is that Ontario Hydro has always consistently met the regulations and targets set by the government, and in fact has met it with a margin in most years.

So that's the record.

[2:45 p.m.]

Q. But, Mr. Penn, the record includes

the fact that Ontario Hydro has turned to imports specifically to honour the letter of the law, but, Mr. Penn, do you view that as honouring the spirit of the law?

A. Well, I don't think I have any personal views on that matter. I was just stating the fact, Mr. Poch, that Hydro has always met the limits, and they have already dropped on two occasions, and we continue to meet the limit.

I understand that there is a provision in that Act and I am no expert in this matter, but I understand there is a provision that in the event that Hydro had serious difficulties it would discuss the matter with the government.

Q. Mr. Penn, maybe we should talk about this without the context of that regulation because, of course, acid gas and carbon are acid gas and carbon whether they are below the cap or above the cap -- let me rephrase my question, then.

Would you agree that by relying on nuclear to the extent you have unexpected outages it is going to imply a reliance, a fallback on coal and emissions?

A. Well, only to the extent that the regulations set by the government would allow us to.

Q. Or to the extent that you buy coal from out of province, coal-fired power from out of province?

A. We certainly have bought power from the United States, yes.

Q. All right.

A. We also bought a lot of power from Hydro Quebec, of course, which is hydroelectric power. And Manitoba.

Q. Okay. Could we turn up -- excuse me. I will just check the page. Yes, page 48 of my materials.

This is the last page of Mr. Fraser's second report. It is in Volume 1 of our materials. It is Exhibit 585, page 13 of that exhibit, page 48 of our volume.

Now, there Mr. Fraser has conveniently for us, assembled your CES forecast. Mr. Daly, you spoke of CES yesterday. That stands for what?

MR. DALY: A. Consistent Energy Set.

Q. And that is the current basis of your performance forecasting?

A. Yes, that is the main process that we use in making forecasts typically over the next five to six years.

Q. All right. He was just comparing there your forecasts and your actuals within the first few years of the forecast, and I, just judging the last column, see that there has typically been about a 15 per cent variance even in those first few years.

Would you agree that that has been the pattern?

A. I think the table is somewhat misleading, Mr. Poch. We appear to have about eight or nine different forecasts.

In fact, what we are looking at here is just simply two forecasts. We are looking at CES 83-1, which was done in about November of 1982. So it was done about six to seven months prior to the Pickering retubing. So the Pickering retubing, as we have said, was a surprise, and obviously that made all future years in error. After CES 83-1, recognizing the Pickering pressure tube failure, our subsequent forecasts for '85, '86, '87 and '88 were changed.

So I think when you are looking at that table you have to take that point into consideration, that our forecast, the CES process continually updates the forecast, and obviously we had to change the forecast after the pressure tube failure.

Similarly, CES 87-2 was a forecast

prepared around the time that Darlington was anticipated to first come into service, and, as you know, we have experienced delays in Darlington. So the delays in Darlington contributed to a large amount of the difference in the latter years.

So I think it is important to recognize that we are looking at two forecasts here: one done just before the Pickering retubing, and another done just before Darlington was coming into service.

Q. Indeed, we are looking at, if you will, one forecast in this hearing which covers a great many years. Each of these forecasts has five years' different sub-forecasts, if you will, included for five separate years, and what we are looking at now in terms of a planning decision is a single forecast which has up to 25 years included?

A. That's correct. And as I mentioned earlier, as a result of differences between our forecasts and our actual we have made adjustments to those forecasts, and we discussed some of them this morning.

Q. Mr. Daly, I can't resist asking. Under CES 83-1 for '84 it was forecasting 49.6 per cent.

A. 49.6 terawatthours.

Q. Oh, terawatthours. Yes, all right. And the increasing pattern there is simply because you are bringing more units into service?

A. Correct. We were bringing the "B" units into service during that period.

Q. Now, Mr. Fraser in his report, if you turn back to page 44 of our exhibit, the last paragraph reads:

> Hydro's poor forecasting record and continued operating problems at its nuclear stations suggest that its forecasts of nuclear performance are optimistic. As existing nuclear supply, including Darlington, is expected to count for over half the energy generated during the DSP period, a significant error in the nuclear supply forecast can have a significant effect on the entire plan.
>
> The Ontario Energy Board has criticized Hydro's consistently optimistic nuclear supply forecasts. Hydro's forecast of nuclear production is expected to be a source of criticism by Intervenors at the public hearing into

Hydro's Demand/Supply Plan.

Well, I can certainly confirm the last statement for you, Mr. Daly.

Is it your understanding, do you understand and agree that the forecast of performance does in fact have a critical or a significant effect on the entire plan?

A. Yes.

Q. Now, at page 54 of our materials is included an excerpt --

A. Sorry. I might add to that perhaps less so with the updated plan in which nuclear does not have such a large role.

Q. Yes.

A. But with that qualification.

Q. Certainly. At page 54 for convenience I just excerpted part of the transcript of these proceedings. This would have been, I am guessing, Panel 3.

And there we had a discussion where I was asking for sensitivity analyses for avoided cost for lower nuclear performance, but I wanted the sensitivity analysis --

Mr. Chairman, my recollection - I'm sure there is no dispute about this - the sensitivity

analysis that was offered included, you may recall, substituting more nuclear in the avoided cost assumption for declining nuclear performance, and I was asking at the time for a sensitivity analysis which didn't make that assumption.

No undertaking was given at that time because we agreed that counsel would speak about the matter. Counsel did speak about the matter, and you can see at page 57 a letter from Mr. Campbell, and this particular matter is dealt with at the bottom of page 58. Basically, the last sentence on that page is:

> Hydro has not examined avoided cost sensitivity to lower nuclear availability without new nuclear in the future generation mix.

First of all, can I confirm with you, Mr. Daly, that in 9.30.2, which we referred to earlier, where you gave us differing incapability assumptions - and you recall I cited the one for 20 per cent and one for 30 per cent - and we showed the LUEC wasn't -- you recall it wasn't linear related?

LUEC is not synonymous with avoided cost, I take it?

A. I really don't have any knowledge in the area of avoided costs.

Q. All right. Let's leave that aside, then.

Perhaps I can renew my request, then, for a sensitivity of avoided cost unless you gentlemen today can provide me with one or point me to one where you don't -- that is, a sensitivity of avoided cost to nuclear performance where we do not make the assumption that nuclear is a substitute for nuclear.

I think you will appreciate our concern that if indeed nuclear performance did decline significantly it would likely lead to a planning decision to place less reliance on nuclear in the new generation. I am wondering if that could be provided.

MS. HARVIE: Well, Mr. Chairman, if I may address that point, this is not a matter that I have instructions on at this point. I have no idea what kind of work is involved in preparing that type of a sensitivity analysis.

As you can see from the correspondence, there has been quite a bit of discussion back and forth between Mr. Poch and Ontario Hydro, and all I can suggest at this time is that we take it under advisement and we get back to him with some clearer direction, if that is necessary.

MR. D. POCH: Mr. Chairman, I raise it

now and I am happy to talk to my friend off the record at the end of today.

THE CHAIRMAN: Have you replied to this letter of February 28th?

MR. D. POCH: No, I don't believe I have, Mr. Chairman, not on that point. I thought Mr. Campbell was pretty clear that they are not interested in providing it there. Since it never really received the status of an undertaking in the earlier panel I felt it was appropriate to raise it again.

THE CHAIRMAN: We will leave it the way you suggest.

MR. D. POCH: So perhaps I will speak to Mr. Campbell or Ms. Harvie this evening, and, if necessary, we will bring the matter before you tomorrow, sir. My interest, of course, is in having this in time for Panel 10.

Q. Let's turn to OM&A for a moment.

In Exhibit 519 you provided an analysis of OM&A, and you pointed us to how it is rising of late. Mr. Heintzman spent some time with you on this, and I think I have already pointed out in our second volume at page 77 how we asked for your originally anticipated OM&A, and you declined to provide that.

Nevertheless, would it be fair for us to

assume that your original proposals for Darlington certainly didn't include the doubling of OM&A we have seen?

MR. PENN: A. I'm afraid I don't have the detail on what was originally anticipated in Darlington operations cost.

Do you have that, Mr. Daly?

MR. DALY: A. I don't have it. The original Darlington estimates must have been made in the mid-70s. I have not personally seen them.

Q. You told us that despite the doubling --

THE CHAIRMAN: First of all, does everyone agree it has been doubled? Is that understood?

MR. D. POCH: Just to help you here, if you turn up page 69 of Exhibit 519.

THE CHAIRMAN: That is helpful.

MR. D. POCH: Q. I guess, strictly speaking, gentlemen, the doubling is from the level in the '86 period to the level shown in that graph for the current period, but it did vary before then, including to the higher levels.

MR. PENN: A. Yes, I can confirm that.

THE CHAIRMAN: From what period to what

period?

MR. D. POCH: I was just noting, Mr. Chairman, in the period sort of '85 to '87 it hovered just before $40 per kilowatt, and these are in constant dollars, and is now up over $80 at the right-hand side of the graph there.

Q. Mr. Daly, I want to make sure I understand your evidence with respect to the comparison that was made to the U.S. situation.

You are saying that despite this rise, a doubling in recent years, you are still about half of typical U.S. OM&A levels? And you gave a number of reasons, I think.

MR. DALY: A. Yes. I think Mr. Penn originally gave that evidence and I confirmed it later with Mr. Heintzman.

Q. You also, I believe, suggested that -- or I'm sorry, it was I think placed as a proposition before you that increasing OM&A even more would improve performance. You have certainly given evidence that you are expecting better performance from the increase you have allocated?

A. Correct.

Q. I wanted to look at the next proposition which flows, which is a question which

arises, it seems to me, which is: Would you increase performance further with a further allocation?

A. Do you wish me to comment on that?

Q. I was going to take you to the exhibit so you could comment within the context, if that is acceptable.

First of all, at page 62 of Exhibit 519 can we agree that OM&A accounts for roughly 20 per cent of your nuclear cost?

MR. PENN: A. That is right, for new station.

Q. So if we went to U.S. levels of OM&A - that is, doubled this OM&A budget - you could be increasing LUEC by as much as 20 per cent, apart from any offsetting benefits that you derive?

A. I think I would have to think about it, because OM&A costs are over the full 40 years, whereas the initial capital cost is upfront. I'm not quite sure in the levelizing process whether it is as simple as that, Mr. Poch. I'm sorry, but that is the best I can do.

[3:05 p.m.]

Q. That is fine.

I can appreciate if it just went up a certain amount this would present difficulty, but I had

taken it that since OM&A, whatever percentage it may be on a year to year basis, once you levelize it is 20 per cent.

The numbers on page 62 are the levelized cost?

A. Yes, they are.

Q. So then if we double OM&A, and it may amount to 10 per cent in one year and 30 per cent in another year, but in its levelized basis if we consistently double it throughout the period, would I not be correct then in my understanding that the LUEC would increase by the same amount?

A. Well, theoretically I think if you consistently increased it from year 1 through to year 40, that you are likely right.

Q. Okay. Now, Mr. Daly, in fact, you couldn't increase nuclear performance consistently 20 per cent above your forecast, could you, because you have certain outages which are unavoidable?

MR. DALY: A. We have certain planned outages, yes. There are some units - for example, Bruce "A" currently operating around 50 per cent - there are some units where we could increase by more than 20 per cent. But on average, as I said our average performance has been about 75 per cent, and the

best we have typically achieved on a multi-year basis is of the order of 85 to 90 per cent.

Q. All right. And indeed you have already spoken that once you include retubing outages obviously that reduces the potential, also things like vacuum building inspections you spoke of earlier, that's unavoidable, it's a regulatory requirement.

A. Once every 10 years.

Q. So is it fair to say then that we couldn't expect if we went to that extreme of doubling OM&A to get equivalent benefits in terms of performance?

A. I think there is a law of diminishing returns, that the first few million or so you put into increased OM&A, in effect the amount that we put in to date we do expect to get a significant benefit from that, as you put in more again there is a law of diminishing returns.

We have described a model that indicates the type of correlation between OM&A spending and capability factor that we sort of qualitatively see, so we use that model to assist us in judging what is the appropriate level of OM&A. And clearly we don't want too little and clearly we don't want too much either, because, as you say, it would drive up the total cost.

So there is a balance and we are working to get to that balance.

Q. There is an optimal level.

A. There is an optimal level, yes.

A. Yes.

Q. If performance were to continue to decline over time, you might respond with more OM&A expenditure, but that at a point that would become counter-productive in terms of cost?

A. Yes, it would depend, some performance declines are related to OM&A, we believe, other declines are more due to a particular technical factor that isn't sort of OM&A related.

So we look at the factors contributing to performance and in some cases we believe OM&A is the appropriate fix, in other cases it isn't.

Q. You have provided us with the current figure which you spoke of a moment ago if $82 a kilowatt at page 69 of Exhibit 519. Could you help me, what would be the number that was assumed by Ontario Nuclear Cost inquiry and by you in your submissions to them?

MR. PENN: A. Well, the subject of OM&A in the ONCI Inquiry is covered in chapters 26 through to 29.

Q. Are you looking in the ONCI report or your submissions?

A. Yes, Exhibit 43.

Q. That's Hydro's presentation to the Nuclear Cost Inquiry?

A. Yes, it is.

Q. And I can see figures quoted in millions of dollars per year, but I can't see, without reading this in detail, dollars per kilowatt to be able to compare it with the $82 a kilowatt that you mentioned existed in 1991.

Q. Perhaps I can leave that with you and when you have a little more time you can see if... It's not obvious to me.

A. We have it in terms of levelized unit energy cost, of course. We have it in terms of LUEC for existing site of .66 cents per kilowatthour, or 22.3 per cent of the total LUEC, so it's a similar number to the 20 per cent. And for a new site it's - this is on system expansion basis - 23.7 per cent of levelized units energy cost. And in those days, the levelized unit energy cost for a new site was 3.2 cents a kilowatthour and 2.9 cents a kilowatthour for an existing site, all being in 1988 dollars of the year.

So the I think the answer is it's very

similar.

Q. It's similar. Okay. That's the answer.

I was wondering, in other words, if ONCI and you were aware of this expected substantial increase?

A. Yes, there was a discussion of the needed increase in costs in OM&A in the ONCI Exhibit 43.

Q. So it was assumed there.

A. Yes, it was.

Q. Okay. Thank you.

Could you turn up Exhibit 540, this is a document filed by AECL, and it was Nuclear Station Operating Costs, Ontario Hydro and the U.S. Nuclear Industry.

A. Yes, we have that.

Q. Chart 8, which is on page 7, Mr. Heintzman, I think, referred you to this, and this is nuclear LOE per gigawatt. This is a measure of operating expenditures, I guess it would be levelized operating expenditures?

MR. DALY: A. I believe that's level of effort.

MR. PENN: A. There is a definition of

that term somewhere in this paper.

On page 2, defined as...

MR. DALY: A. Yes, footnote 1 on that page, level of effort. Footnote 1 on page 2.

Q. Could you just tell me what -- well, all right.

MR. PENN: A. The level of effort per unit is the total number of man years divided by the number of units in the station.

Q. And in fact, just on the prior page there is nuclear OM&A as you would orderly measure these.

But in either of these graphs I take it that the OM&A or level of unit over the four or five years, the five-year period charted there in the States has in fact been growing faster than 1 per cent per year.

A. Are you looking at chart 5 when you say that?

Q. Well, chart 5 is a slightly different pattern. I was looking at level of effort but...

A. You are on chart 7?

Q. You can look at chart 5 or 7, I think.

A. Well, chart 5 I think shows that the

EUCG data, which is mainly United States, that it reduced in 1989 relative to--

Q. In that one year?

A. --'88.

I'm eyeballing it, but '88 looks a smidgen smaller than '87 to me.

Q. Well, I was taking the entire period, averaging for the period. Obviously these things can fluctuate from year to year, and I just saw an increase of $21 compared to the base of 77 over that five-year period. So I thought it was taking it on that basis.

It's certainly more than 1 per cent average.

A. Well, I would agree on average, but in the last three years I think that it has been less than the average.

Q. In fact, from '87 to '88 it was more than 1 per cent; it was about 4 per cent. I am just looking at chart 5, nuclear OM&A, the upper figures.

A. We are talking about the EUCG data, are we?

Q. Yes. I am sorry, that's not the United States. That's more than United States; isn't it?

A. Well, in these days it would be

almost entirely the United States apart from Ontario Hydro, because EDF and Korea haven't joined until recently. But I would have to check.

It seems to me that I take 28.2 away from 94.9, and I compare it with 98.7 minus 33.9.

Q. I may be reading this chart differently than you. I did not assume you would subtract one from the other. I assumed the upper figure was the...

A. Well, the way I interpret this figure is that the EUCG data is the upper part of the graph and the Ontario Hydro data is the bottom part.

Q. You assumed then that EUCG is not, for example, in '87 94.9 but rather is only the upper part and you have to actually subtract to make sense of this graph?

I had just assumed that one is sort of overlaid on top of the other. Perhaps...

A. Well, short of reading the text I can't tell, but that's how I would normally interpret this sort of bar chart.

MR. DALY: A. I think perhaps, Mr. Poch, we would have to check that one and perhaps we can check that at the break and advise you on that.

Q. Yes, I think I can help you. If you

just turn back to page 3, there they separate the bars and put them next to each other. You can see that we still get up into the $90 range for EUCG.

Does that help?

MR. PENN: A. I would have to agree with you on chart 1. It would appear that in separate 1988 and then 1989 dollars, that EUCG data is about 2.8 times Ontario Hydro.

Q. So from that we can then assume in chart 5, for example, the upper number offered is in fact the number for EUCG.

A. Well, I think we can. They are in different dollars.

Q. That is fine.

A. They are in constant dollars on that other graph.

Q. I take it you would agree for that period averaged, they are certainly increasing in the EUCG more than 1 per cent per year?

A. On that basis, I would have to agree with you, yes.

Q. I think you have already given evidence, your forecast assumes OM&A increasing at 1 per cent per year after this rise we have just experienced for Ontario Hydro in your plans?

A. Yes, and I qualify my previous comment that over the five-year period you are quite right, but over the period 1988, 1989, and I think from our direct evidence, 1990, that the increase in the United States has not been the average.

Q. Yes. And you did indicate that performance seems to be improving in the States. I think that was your evidence, Mr. Daly.

MR. DALY: A. Yes, performance in the States has improved approximately 10 per cent over the last 10 years.

Q. Could you look at look at Mr. Komanoff's evidence, Exhibit 563, at page 13.

A. Page 13?

Q. Yes.

In the highlighted box, in the lower part of that box he offers the average capacity factor for the eldest, I think it indicates in the text, 47 U.S. plants.

A. Yes, I see that table.

Q. Does that also accord with your understanding that there is this pattern?

A. That accords with our understanding that the small number of early units have that sort of average capacity factor.

What I would point to in this particular chart is that the U.S. seems to be learning from experience as their plants get older, because if we look at the plants that are aged 18 and 19, given any sort of reasonable performance, when these plants come through to their years 22, 23, they are likely to have a much greater average capacity factor than the 44 and 31 shown there. So I think that should also -- that's one other understanding I take from that type of distribution.

[3:20 p.m.]

Q. All right. And finally in this area, Mr. Daly, there were at least two discussions I recall about this you had with Mr. Bullock about this relationship between OM&A and performance, and I recall you came back and the record was corrected.

Can we just sum it up? Do I now understand correctly, of the decline in performance experienced in this '82 to '87 period you attribute perhaps a quarter of that to insufficient OM&A?

A. I was trying to give Mr. Bullock a sort of order of magnitude.

Q. Yes.

A. When we have done this type of calculation using that model we have typically felt

that had we had the appropriate amount of OM&A we might have been 2 per cent, 3 per cent, 4 per cent better. It was of that sort of order of magnitude.

There were more significant factors such as the retubing at that particular time, but, generally speaking, we came one 2 to 4 per cent capability factor in that period '83 to about '88, and, as I indicated to him, it would not be appropriate to apply to that 1990 because that was a highly unusual year, and many of the things that faced us in 1990 were not--

Q. Yes.

A. --really OM&A related.

Q. I recall that. Okay. Thank you. I am going to turn to a new topic.

DR. CONNELL: Mr. Poch, I would like to just ask a question about Mr. Komanoff's paper, if I may. I understand we will have a chance to speak to him later, but I think in the meantime it might be helpful if we could have a little more insight into his figure 2.

Just on a cursory reading of the text, I am not clear exactly how he derived his regression curve except a reference to statistical regression packages, but I think it would be helpful to have some data points on this curve, and if it wouldn't be too

much trouble, Mr. Daly, I wonder if a member of your staff could simply blow up this curve and put some points on it.

I assume that he must have done his regression unit by unit. Is that your impression?

MR. DALY: I believe he did, and I referred to Mr. Poch earlier and he indicated where some of this information is, he referred us to the historical tables--

MR. D. POCH: Yes.

MR. DALY: --in the Appendix 2. However, we don't have the future data or the future assumptions or curve-fitting process that Mr. Komanoff used.

This particular chart is somewhat different from the chart he has provided in the past at the OEB. The OEB information, we have the majority of that, but we don't have the information, the future information that Mr. Komanoff used here. So I would have to --

DR. CONNELL: Actually, I am not interested in the future at the moment, just the record. In fact, if the regression was based on the data in Appendix 2 I think simply to plot the relevant points on --

MR. D. POCH: Yes, Dr. Connell. I think

I may be able to help a little, and perhaps I should ask you.

Appendix 1 provides some summary statistics. Appendix 2 provides the data base actually employed and the value of each variable in the formula for any given unit for any given historical year. Appendix 3 provides the year-by-year figure for the collective, if you will, going outwards.

I suppose the only thing that isn't here is the actual formula and that certainly can be provided, if that is of assistance.

DR. CONNELL: Yes, that might be useful later, but at the moment I would simply like to gain some visual impression of the basis for the extrapolation, and my instinct tells me that it would be probably most useful to look at it on a unit-by-unit basis rather than the collected averages, although both might be of interest.

MR. D. POCH: Yes. I am just guessing now, but I am assuming that the difficulty with unit-by-unit is the insufficient data set for statistical reliability. We are back to epidemiology here, we need a large enough sample to be able to have statistical confidence.

But I will convey those observations to

Mr. Komanoff, and so he will perhaps be able to offer some assistance to you when the time comes.

DR. CONNELL: So you think we can lean on him rather than our distinguished panel?

MR. D. POCH: I am happy to have you lean on Hydro's Panel 2, sir. In fact, I would be very interested in seeing their analysis.

MR. DALY: I think, Dr. Connell, our analysis differs from Mr. Komanoff's who is using slightly different techniques. I think if you want insight into this particular chart Mr. Komanoff is the appropriate person to provide it.

We have provided our own forecasts in my direct evidence, and we tried to indicate the basis of those. Mr. Komanoff uses a different approach. So I think he has to provide the information related to this chart, since it is his chart, it is not ours.

DR. CONNELL: Well, before I buy anyone's approach I think I would just like to be able to eyeball the data and form my own impressions, my own biases, so to speak.

MR. D. POCH: Dr. Connell, would you looking for something in the nature of like a scatter diagram--

DR. CONNELL: Yes.

MR. D. POCH: --which has the points surrounding the line?

DR. CONNELL: Yes.

MR. D. POCH: So we can see how the line weighted?

DR. CONNELL: Yes. Even without the line perhaps initially.

MR. D. POCH: Sure. Well, I will see if that is available, Dr. Connell.

DR. CONNELL: Thank you.

MR. DALY: I think, Dr. Connell, we also have some had some analysis of Mr. Komanoff's data in, I believe it was, Interrogatory 9.2.30.

THE REGISTRAR: 9.2.30?

MR. DALY: 9.2.30, which was some analyses Ontario Hydro did of Mr. Komanoff's work.

MR. D. POCH: Mr. Daly, I take it that would have been of an earlier model, the model presented to the OEB back in the late 80s?

MR. DALY: That would have been the linear regression model, yes.

THE REGISTRAR: That will take the number .79.

THE CHAIRMAN: Thank you.

---EXHIBIT NO. 520.79: Interrogatory No. 9.2.30.

MR. D. POCH: Mr. Chairman, I was about to turn to another topic now.

THE CHAIRMAN: Shall we take a break for 15 minutes?

THE REGISTRAR: Please come to order. This hearing will recess for 15 minutes.

---Recess at 3:34 p.m.

---On resuming at 3:53 p.m.

THE REGISTRAR: Please come to order. This hearing is again in session. Be seated, please.

THE CHAIRMAN: Mr. Poch?

MR. D. POCH: Thank you, Mr. Chairman.

Q. Gentlemen, in looking at your options - there is a range of them - some of them are a different type, and some of them are - and I am cognizant of all the evidence on how extensive the difference is - but some of them are evolutionary. So I wanted to look with you at the changes we have seen between generations of reactors.

Could you turn up page 60 of our first volume of materials?

Now, here we have compiled some information from various Ontario Hydro supplied interrogatory answers and the note 1 gives the source.

THE CHAIRMAN: Whose document is this?

MR. D. POCH: This is a document compiled by the CEG, Mr. Chairman.

THE CHAIRMAN: Right.

MR. D. POCH: And it pulls together data provided in the interrogatories noted in note 1, and we have in the following pages provided, I believe, all of the Hydro sources for those numbers so they will be at hand for this discussion.

THE CHAIRMAN: That runs through to what page, Mr. Poch? Do you know?

MR. D. POCH: I will have to check, Mr. Chairman.

The following pages up to and including page 68.

THE CHAIRMAN: All right.

MR. D. POCH: And there in fact are some other related Hydro answers.

THE CHAIRMAN: And on page 68 the Ontario Hydro deflators, that is also your source, too, is it?

MR. D. POCH: Page 68 as opposed to the intervening pages, which are Hydro exhibits, is something again we have produced which just puts on one page Hydro's nuclear cost escalator and the GDP deflator.

THE CHAIRMAN: Would it be appropriate to

put pages 60 to 68 in as -- would that be an appropriate thing to do?

MR. D. POCH: I am content, Mr. Chairman. Of course, it does include some Hydro interrogatories, but as long as --

THE CHAIRMAN: Well, I just want to make sure it is convenient for someone following the transcript, what they have to look at.

MR. D. POCH: All right. That is certainly satisfactory to me, Mr. Chairman.

THE CHAIRMAN: Can we do that then, Mr. Lucas, give a new exhibit number to pages 60 to 68, inclusive?

THE REGISTRAR: From 60 to 68, inclusive?

THE CHAIRMAN: Yes.

THE REGISTRAR: That will be number 589.

---EXHIBIT NO. 589: Pages 60 to 68, inclusive, from Exhibit 577.

THE CHAIRMAN: Then, I guess just to show a cross-reference just -- there are two interrogatories one on page 62 and one on page 64, and they should be given 520 numbers.

THE REGISTRAR: The one on page 62, 9.7.448, is .80.

---EXHIBIT NO. 520.80: Interrogatory No. 9.7.448.

THE REGISTRAR: The one on page 64 is 9.7.453, is .81.

THE CHAIRMAN: Thank you. Sorry, Mr. Poch.

---EXHIBIT NO. 520.81: Interrogatory No. 9.7.453.

MR. D. POCH: The next two pages are from Hydro's '91 Business Plan, and page 67 is an attachment from Interrogatory 9.7.62.

THE CHAIRMAN: Shall we record -- perhaps we should record 9.7.62 if it hasn't already been recorded.

THE REGISTRAR: I am just checking. 9.7.62 has been filed as .74.

THE CHAIRMAN: All right.

MR. D. POCH: Q. Okay. Now, this exhibit shows the cost per kilowatt to construct each of Hydro's five groups of reactors, five stations, and we have put them in chronological order, Pickering "A" through Darlington.

Do you see that, Mr. Penn?

MR. PENN: A. Yes, I do.

Q. We have four different columns of cost data, and all of them are in dollars per kilowatt, and the dollars are end of 1990 dollars, I am told.

Do you see those columns?

A. Yes, I can.

Q. And the first one being Total Station Cost, the second Total Cost Without Interest, the third is Total Cost With Interest But Without Fuel and Heavy Water, and the final column excludes interest and excludes fuel and heavy water.

Can you see that?

A. Yes, I can.

Q. Now, to deal with the notion of generations we have chosen to compress this data into three groups, "A" stations by averaging the "A" data on a per kilowatt basis - so that would be Pickering "A" and Bruce "A" would fall into the "A" station line in the middle section of this page - similarly for the "B" stations, and we have left Darlington as a third generation.

Still with me?

A. Yes, I am.

Q. I will let you know that Darlington cost is based on Interrogatory 9.7.448, which is one of the ones attached, which is dated November 15th, '91, which was the most recent data we had at the time they prepared this.

Just to be clear, that says 13.5 billion. In fact, we now have your evidence and Mr. McCredie's

which raises that slightly to 13.8.

I want to talk to you about cost increases from the "A"s.

THE CHAIRMAN: I'm sorry, where do we see 13.5?

MR. D. POCH: That is at page 62, Mr. Chairman, in Part A of the response.

THE CHAIRMAN: Okay. All right. Thank you.

MR. D. POCH: Q. I thought to simplify matters we would just take the last column, Mr. Penn, which excludes interest and excludes fuel and heavy water, so that would be direct costs construction, commissioning and training, and so on?

MR. PENN: A. Yes.

Q. Now, according to the information you provided us here, and we have compiled the average construction cost, that last column, per kilowatt of the "B" stations, was 27.9 per cent more than in the "A" stations. Do you see that cost escalation between stations, the third grouping?

A. Yes, I can see your numbers, yes.

Q. All right. And that accords, I take it, with your understanding?

A. Pardon?

Q. That accords with your understanding of the numbers? I am not asking you to agree to the significant digits, but...

A. I think it is an inappropriate comparison, but if you average the cost of the "A" stations and average the cost of the "B" stations without any concern for the differences of one station from another I would agree you get that number.

Q. Yes. Mr. Penn, I am not seeking to imply with this, and I am not seeking for you to adopt, the notion that there have not been significant changes from station to station. Indeed, there have been changes in design, and changes of scope, changes of regulatory demand. I think we have heard the evidence on that.

A. And many more, many other reasons as well.

Q. Yes. Sure. I was going to ask you about that. It is those kinds of things which you would assign that roughly 28 per cent to?

THE CHAIRMAN: What 28 per cent? Oh, the --

MR. D. POCH: 27.9. I am rounding it to 28, Mr. Chairman.

THE CHAIRMAN: All right.

MR. PENN: I'm sorry, did you ask me a question?

MR. D. POCH: Q. Yes. My next question was going to be: What caused the 28 per cent? And I think you and I can agree then it is many factors, and I have just mentioned three you agreed to, and you indicated there were many others.

MR. PENN: A. Well, I would just like to note that this is an annotated version of Interrogatory 8.2.14, which provides considerable detail and explanation of the various costs.

Q. Yes. And, in fact, the excerpt from 8.2.14 is the overleaf here.

A. Well, the excerpt on page 61, what that is, is the initial capital cost, including heavy water but without any capital modifications during the history of these stations, and, of course, there is extensive data in 8.2.14 that provides a commentary and also provides a listing of capital modifications, and, of course, uses a constant interest rate or discount rate of 4 per cent.

Q. All right. And indeed, just to be --

A. Which brings me to the question--

Q. Yes?

A. --on how you have calculated the

Darlington cost.

[4:05 p.m.]

The only reason that I make this point is that on table 1 which is attached to Exhibit 520.80, what is provided there is in dollars of the year, the actual interest on the design and construction, the $4.85 billion. But as we have given in evidence, the actual interest on Darlington is as high as $5.8 billion, and what the reason for that difference is that of course the interest on the heavy water and on the OM&A and the commissioning and training is not noted in this table, it's part of those numbers given.

So I think it would be very difficult for you to calculate Darlington because of that information lack that you would have.

Q. I'm sorry, I was looking at the Without Interest.

A. Well, to get the last column without interest, you have to know what the interest is. And the column that's marked With Interest, without fuel or D2O, I am saying is taken from Interrogatory 8.2.14, and actually includes a real interest rate of 4 per cent, whereas the figures you have got for Darlington, you wouldn't know that.

THE REGISTRAR: 8.2.14, becomes .82.

THE CHAIRMAN: Right.

---EXHIBIT NO. 520.82: Interrogatory No. 8.2.14.

MR. D. POCH: Q. I am having a little difficulty following you, Mr. Penn. I was looking at page 63 of our exhibit.

MR. PENN: A. Yes.

Q. And we took the numbers from here, I believe, for Darlington, and this is from your 1991 business plan, do you recognize it?

A. I think it says in the response to 9.7.448 that the Darlington estimate of 13.5 billion detailed by the cost items shown on page 5 of the attachment to the response to Interrogatory 9.7.74.

The point that I was trying it make to you, Mr. Poch, is that if we look at the top of your page 60, for each of Pickering "A", Bruce "A", Pickering "B" and Bruce "B", all those numbers come from Exhibit 520.82. And the column marked Without Interest, the column marked With Interest that you have used to obtain the final column on the right-hand side, the column With Interest includes a 4 per cent constant interest. That's the agreement of the Electric Utility Cost Group. That's how we can compare United States plants with Canadian and with French and Korea and all the rest of it, we have agreed internationally to do

that.

Whereas the costs for Darlington you have calculated from dollars of the year based upon the table on page 63, and I have noted to you that in that table only about 4/5ths of the interest is specifically detailed.

So, in order for you to calculate Darlington you would have to do two things: You would have to know how much interest was associated with commissioning, training, half the initial fuel, heavy water; in other words, the total nuclear operations branch total, and you would also have to know what the CPI was in order to calculate the real interest over the cash flow when this money was spent.

So I am just trying to point out there is an inconsistently here in your data.

THE CHAIRMAN: And that relates to Darlington only.

MR. PENN: Yes, sir.

MR. D. POCH: Excuse me, panel, I will see if my colleague is understanding what you are saying.

Mr. Penn, I will have to take your comments and pass them along to the person who constructed this for me.

THE CHAIRMAN: Just so I understand it, if I don't confuse it by saying, first of all, you have got to know what the actual interest figure is and then you have convert that actual figure into the 4 per cent real interest for comparative purposes.

MR. PENN: That's basically correct, sir, yes.

The other point I was trying to make, Mr. Chairman, and maybe I haven't made it clearly enough, is that on page 63, as we have heard in prior evidence that I have given, the interest to date on Darlington is $5.8 billion, whereas this table only shows 4.85 billion.

THE CHAIRMAN: You have got to find out what the actual interest is and then make the conversion.

MR. PENN: Yes, sir.

MR. D. POCH: Q. Just so I understand, the difference between the 4.8 billion in interest that you have provided us in this table in the '91 business plan and the 5.8, could you tell me again where that difference arises from?

MR. PENN: A. Well, in the exhibit we discussed, I think it was yesterday, that the project manager of Darlington provided, I have forgotten it's

number now.

Q. It's 539.

A. 539. Maybe we should look at that and so we are quite clear on what I am talking about.

Right on page 1 of Exhibit 539, the first bullet says:

> Darlington is presently estimated to cost 13.8 billion when complete in 1993. This includes about 5.8 billion or 42 per cent in interest charges.

And then it provides a table on Appendix 3, a series of bar charts, where for the year '92 it breaks the estimate down into interest at the top of the bar, of production branch costs in the middle--

Q. I am sorry which page is this on?

A. --and design and construction at the bottom.

Q. Yes, I have that.

A. And the top of the bar, interest amounts to 5.8 billion, and I think probably with a straight line you could scale that.

Now, turning now to table 1 that accompanied Interrogatory 9.7.448 or Exhibit 520.80, what this table shows you when the estimated cost to completion was 13-1/2 billion, that the interest,

that's in the middle of the table just below overhead, is $4.85 billion.

What I am advising you in this table is that's the interest on design and construction only. You note two lines below it sums design and construction.

And then below design and construction branch total, it gives nuclear operations branch total, and of that total of 2.85 billion, approximately .8 billion is interest.

The remaining part, of course, is the interest that amounts to the difference between the 13.8 billion, the current estimate, and this estimate which is 13.5, and most of that 300 million, or .3 billion is also interest; in fact, it amounts to about .22 billion.

So that is how you can constitute the total interest to the final estimate of 5.8 billion. And I am saying you would have had to have known that to calculate your numbers, and then having known that you would have had to have got the CPI tables out in order to find out the real interest and then you would have had to have realigned that with the other numbers that are 4 per cent real interest.

THE CHAIRMAN: Mr. Penn, just to make

sure, I am looking at page 63. Are we all looking at page 63; is that right?

MR. PENN: Yes, sir.

THE CHAIRMAN: I am looking at interest of four billion eight hundred and fifty million six-sixty-two.

MR. PENN: Yes.

THE CHAIRMAN: And you say that figure should be something different; is that right?

MR. PENN: That is the interest on the design and construction.

THE CHAIRMAN: But that figure is correct, though.

MR. PENN: That figure is correct. But the interest on --

THE CHAIRMAN: Bear with me, bear with me.

So that the items that have to be adjusted are, first of all, the nuclear operations branch total; is that right, of 2-million eight hundred and fifty-four; is that right?

MR. PENN: That's the total cost.

MR. D. POCH: Two billion, Mr. Chairman.

THE CHAIRMAN: Two billion, I'm sorry.

MR. PENN: And .8 billion of that is

interest, actually.

THE CHAIRMAN: Eight billion.

MR. PENN: .8 billion.

THE CHAIRMAN: .8 billion or 800 million.

MR. PENN: Yes, sir.

THE CHAIRMAN: And there is another interest adjustment that you mentioned.

MR. PENN: There is another interest adjustment because the difference between the current estimate to completion of 13.8 billion, and what was given in this table as Mr. Poch noted, this was information correct as of November the 15th, 1991, the difference between those two numbers is nearly 300 million.

THE CHAIRMAN: That's all interest.

MR. PENN: And .22 or $220 million is interest of that amount.

THE CHAIRMAN: Okay.

MR. PENN: So that's who how you come to 5.8 billion interest.

THE CHAIRMAN: All right. Thank you.

MR. D. POCH: Q. Mr. Penn, if you wanted to reconstruct the chart at page 60, are you telling me that I would need to deduct .8 billion from the Darlington cost there, which is the interest we didn't

realize was buried in the other figures?

MR. PENN: A. What you would be better off doing, I would suggest, is you can take the Darlington costs as of today, you can subtract the interest, the 5.8 billion, you can divide it by the number of kilowatts that Darlington is rated at and you will get the dollars per kilowatt, and then you should add back in 4 per cent real interest, and then you would get a number that is consistent with the four numbers above that.

Q. All right. Well, we will take a look at that, Mr. Penn.

THE CHAIRMAN: Just again, I'm sorry, Mr. Penn. But there is no problem in the presentation with that set of numbers at the top except for the Darlington numbers; is that right?

MR. PENN: That's quite correct, sir. And those numbers with come directly out of this Interrogatory 8.2.14.

MR. D. POCH: Q. So I take it you have no problem with the 27.9 per cent from "A" to "B", but the comparisons to Darlington could obviously be affected?

MR. PENN: A. I have no problem with it, no, except that the proper way to look at this is to

plot it on a graph and you can see how Pickering "A" costs were and Bruce "A" costs and Pickering "B" costs and Bruce "B" costs, and then you can see, that rather averaging the lot you can see the trend and you can read this document to find out the reasons.

Q. Can you just then provide us with a number that we could use for the Darlington line and the top set there, it would be four numbers I guess, that in your view would be consistent with the numbers you provided us for the other stations? I don't need to do that right now.

A. It could be provided, yes.

MR. D. POCH: Could we get an undertaking to that effect.

THE REGISTRAR: 532.5.

---UNDERTAKING NO. 532.5: Ontario Hydro undertakes to provide numbers for Darlington consistent with the numbers provided in Pickering and Bruce in Interrogatory 8.2.14.

MR. D. POCH: Q. That would simply be to provide numbers consistent with those provided for Pickering and Bruce stations for the Darlington station as set out on page --

MS. HARVIE: I am advised, Mr. Chairman and Mr. Poch, that request can be done but it may take some time, so whether or not we are able to give you

this information by the time this cross-examination is finished, I can't say, but we will try.

MR. D. POCH: Thank you.

THE CHAIRMAN: So what you are doing, is your just giving the same information for Darlington as you previously gave in Interrogatory 8.2.18, would that be right?

MR. PENN: That's correct, sir.

MR. D. POCH: Q. Now, at page 69 of this material, Interrogatory 9.7.487.

THE REGISTRAR: That is .83.

---EXHIBIT NO. 520.83: Interrogatory No. 9.7.487.

MR. D. POCH: Q. We asked you for an analysis of the differences between Bruce and Darlington for different factors, and you indicated that cost differentials attributed to the requested conditions were not available because they didn't conform to your accounting norms. But you did refer us to two interrogatories, 9.7.102 and 103 where you did provide some information.

I would refer you to 9.7.103 which is at page 74.

THE REGISTRAR: 9.7.103 is .84.

---EXHIBIT NO. 520.84: Interrogatory No. 9.7.103.

MR. D. POCH: Q. And you provided us

with quite a list of changes and new requirements between the stations.

Can I assume that this is to be expected and as you go to a new generation of reactors one can expect that there would be such changes?

MR. PENN: A. Well, these are the changes that have occurred over time.

Q. Yes. And these are just between the Bruce and the Darlington, both square containment?

A. Well, the changes given in this answer are from Pickering "A" to Pickering "B", and from Bruce "A" to Bruce "B", and from Bruce "B" to Darlington "A". And it also comments on project delays at Pickering "B".

And while I notice that, one of the reasons why I objected to you comparing averages of the "A" stations with the "B" stations is that somewhat like Darlington, Pickering "B" was delayed approximately three years, one year for load forecast reductions, and two years because of a manufacturing fault in the steam generators.

Q. So delays are not unique to Darlington.

A. Well, we have suffered two types of delays, one at Darlington and one at Pickering "B".

[4:25 p.m.]

Q. Is it fair to say that we can see here that over time there are changes and these changes continue to occur from station to station as time progresses? This is to be expected?

A. Well, if you are trying to infer that it will continue in the future, I'm not sure that that follows.

This follows the history of the development of nuclear power in Canada right from the early beginnings, and the development of codes, and the development of seismic qualification, and the development of regulatory processes to improve in many cases, most cases, the safety systems at our plants, et cetera. And you will note if you read through this where Pickering "A", for example, has been retrofitted with a later system, and so on, and also Bruce "A".

Q. And just so we are clear, the numbers you provided to ONCI took into account changes you knew at the time were coming down the pike from the AECB but made no allowance for any future such changes, consistent with your position now you don't assume that there necessarily will be any?

A. We assumed, as I testified yesterday, that the extent in terms of man hours and dollars that

we would spend on regulatory, safety-related matters on the next nuclear station was equal in dollar value to Darlington. So I think that presumes that we will continue to expect to see regulatory change, on the basis of course that we expect a lot of the equipment in the plant not to change from one station to the next.

Q. All right. Let's turn to some questions arising from Exhibit 539 which was referred to a moment ago, which is Mr. McCredie's letter.

In his fourth bullet point he says:

> The appropriate starting point for an analysis of Darlington's cost is Hydro's 1981 estimate of $7.4 billion.

See that?

A. Yes.

Q. Could you turn up in the second volume of our materials page 79. This is 9.7.75, which I don't believe has an exhibit number yet.

THE REGISTRAR: Yes, we do, 520.75.

THE CHAIRMAN: 75?

THE REGISTRAR: .75.

MR. D. POCH: Q. And we asked you to provide the originally anticipated total construction costs, and you referred us to 9.7.62 which is the

overleaf at Exhibit .74, page 80.

THE REGISTRAR: That is .74.

MR. D. POCH: Q. And you gave us, when asked what the original estimate was, a 1978 release estimate of $3.95 billion.

MR. PENN: A. Yes. I had asked our staff to give me some confirmation by morning expecting that I might make a change to my testimony in the transaction yesterday.

I am informed that that 3.95 billion was for design and construction costs only, and the total cost including operations cost brought it to approximately $5 billion, but I don't have the exact number. So I don't know if that is anticipating your question, but --

Q. Well, I think it is probably anticipating a request for supplementary funding to redo a whole bunch of analysis, I fear. But we will wait and see.

The release estimate, be it the 3.9 there or the close to 5 you have just told us about, it would be of a greater level of detail than the cost estimates you provided for some of the future options, I take it?

A. Well, it probably would be at less detail than what we have given this hearing for the 4

by 881, which has extensive background to it, but as far as some of the options such as the advanced light water reactors I would agree that this probably has more information behind it.

Q. In '78 you were already busy, well into engineering Darlington?

A. Well, I wouldn't say we were well into it. The plant was committed in 1977, so we were one year into it.

MR. D. POCH: And I would like to file another exhibit.

THE REGISTRAR: No. 590.

---EXHIBIT NO. 590: Excerpts from Select Committee on Energy Report on Darlington, dated December, 1985.

MR. D. POCH: Q. Mr. Penn, you recognize this as excerpts from the Select Committee on Energy Report on Darlington? This is dated December, 1985.

Mr. Chairman, I'm not sure indeed if Ontario Hydro made this an exhibit. I don't believe they did, so perhaps these excerpts could be marked?

THE CHAIRMAN: That has been marked 590.

MR. D. POCH: Oh, I'm sorry. 590?

THE REGISTRAR: 590, yes.

MR. D. POCH: Q. Thank you. Do you see there in the Executive Summary, Mr. Penn, that the

total estimated cost at that time that you told the committee was 10.895 billion?

MR. PENN: A. Well, I see the number. I haven't seen this document before so I may have to read some of it to answer your questions but let me ask you, the 10.895 billion, is that the number as of the date that this was written, 1985?

Q. Yes, I am assuming.

A. Well...

Q. And I assume that is in dollars of the year and all of it had not been spent.

A. Yes, it has to be in dollars of the year. I am just referring back to Exhibit 539 where we provide the various estimates by year since the Darlington project was subject to review on an annual basis right from 1981 to 1992, which is on Appendix 3.

And the figure on our graph in escalated dollars is 10.6 billion, so I...

Q. I will let you check that at some point, but I just wanted to point out here that at that time the Committee met Hydro informed them that 3.66 billion had already been spent and a further 3.385 billion had been irrevocably committed, it is about 7 billion of the close to 11 billion in that estimate.

A. That is what it says, yes.

Q. So that was well along. And can you just look at the back. I think in my copy there is actually two -- yes, the last page appears twice.

There is something called Comparison of Ontario Hydro's Cost Control on Nuclear Projects With Selected U.S. Projects, and the source of that is Ontario Hydro.

A. Yes. Well, it is the same source as Interrogatory 8.2.14. It is EUCG data.

Q. And there we see Ontario Hydro Darlington that the Select Committee was being told, or Ontario Energy Board in prior years was being told, that you were looking at a 128 per cent increase from the release basis?

A. I'm sorry, Mr. Poch. I was still looking at the graph. So where are you on the last page?

Q. I am in the graph, the horizontal line chart on the last page. In the body of that chart there is a line for Darlington, one for cost and one for duration, and the upper one for cost indicates 128 per cent above the release basis?

A. Yes, I can see that number.

Q. So we could just work backwards, couldn't we, from 10.895 or perhaps 10.5 as you have

offered, and we would get down to a number something under 5 billion?

A. Well, we would, yes.

Q. All right. And that was the number that Hydro offered as an appropriate base to the Select Committee, to the Energy Board and to this international study, the release estimate as an appropriate basis for looking at what cost overruns have been or cost control has been?

A. Well, I wasn't at this Select Committee hearing on Darlington so I don't know whether that was the purpose, but I do know that Exhibit 539 points out that on the first page that the original 1973 conceptual estimate of 2.5 billion assumed the whole station would be in service fully by 1984. And there were delays, planned delays.

In 1975 it was 3.2 billion; again, planned in service fully by 1986. The definitive estimate of 7.4 billion assumed total project completion in 1988. So that what you are leading me through with this bar chart on the last page of Exhibit 590 I think has to take those delays into account.

Q. Mr. Penn, I guess what I am getting at here is, and indeed Mr. McCredie is suggesting, that the 7.4 billion figure is appropriate in his fourth

bullet. He says:

> Earlier estimates were developed for planning purposes.

Do you see that in the second line of his fourth bullet? He is distinguishing the 7.4 billion from earlier estimates which were for planning purposes?

A. Yes.

Q. Indeed, isn't the definition of a release estimate, that word 'release' implies that is because the Ontario Hydro Board has released the project, said "Go for it"?

A. Well, it has released the project on the basis that it is approving early work.

Sometimes, and quite often, the corporation makes partial releases so that it can gain more information to firm up the cost, and it is the definitive estimate to which projects are always controlled, they are measured by. It is the result of doing sufficient engineering to be able to actually determine what the construction costs are because you need to know what it is you are trying to build in order to estimate its cost.

Q. Mr. Penn, of course, we are in a planning hearing now, and that is why I am interested in that line.

Darlington received an exemption under the Environmental Assessment Act based on submissions Hydro made at the time in 1977, I believe; is that correct?

A. Well, Mr. Johansen might be able to help me or confirm this, but we prepared an environmental assessment document for Darlington, and it was reviewed by the Ministry of the Environment, and the Minister determined that a public hearing should not be held.

Q. And wasn't one of the reasons that they determined that was that the reactors came into force in '87 and Darlington was already well along in the planning process?

A. Not to my recollection. I think that it was done because load growth was very high, typically up to seven per cent per year compounded, and the Minister and the government in their judgment decided that the project should proceed.

MR. JOHANSEN: A. I might just add, Mr. Poch, that the original submission was in 1975, and there was a final submission in 1976.

Q. So the estimates you were using at the time of making your judgment under the Environmental Assessment Act and you were asking the

Minister to use were these estimates, something below 5 billion. You offered them variously -- 2.5 billion was the '73 conceptual estimate, I believe, and it moves up from there. The '75 conceptual estimate was, I think, 3.2 billion; is that right?

MR. PENN: A. 3.2 billion on the basis that the whole station, all four units, would be fully in service by 1986.

Q. All right. Mr. McCredie offers us a variance analysis in his Exhibit 539 based on this 7.4 billion cost estimate which comes from 1981.

I have in the transcript by the way at page 22,736, line 20, that you have the 1978 release estimate as 3.95 million and I assume that you meant billion. Perhaps we could just note that change.

And it is that number that you are going to look at getting a further update on?

[4:45 p.m.]

A. That's what I referred to earlier, yes. I was informed at lunch time that that was for design and construction only.

Q. And that was for a 1989 in-service?

A. That would be for '88 or '89.

Q. All right. So if we were looking for an estimate that you made of Darlington, 20 years prior

to the average in-service date that has or may come to be, we would be looking at something of a vintage 1972?

A. I'm sorry, I didn't follow your question.

Q. If I wanted to find out what kind of estimates you made of Darlington's costs 20 years prior to the average in-service date, if we take today as the average, optimistically we take today as the average in-service date, we would be looking at estimates you made in '72, and those are the lowest ones you have offered us in range of between 2 and 3 billion dollars; correct?

A. I'm sorry, I am not following the connection to 20 years. Maybe I am getting tired, but I am missing something.

Q. Darlington is coming into service, one unit is in and the next are scheduled to come in over the next year or two.

A. Yes.

Q. So 1992 was the actual in-service.

A. Yes.

Q. On average, roughly.

A. Yes.

Q. And if I was just looking for a parallel, for what kind of estimates you made 20 years

in advance of that, it's in the range of 2 to 3 billion, mixed dollars obviously.

A. I am afraid I am not following you at all. Are you talking about in 1972 dollars?

Q. No. What kind of estimate you were providing for decision-making purposes in 1972, and the estimate there was in forward dollars as they would be spent about around 2-1/2 billion; right?

A. Yes. We state in Exhibit 539 that the original 1973 conceptual estimate was 2.5 billion dollars for in-service by 1984, some eight years previous to this point in time.

Q. All right. So there obviously were a lot of changes between that estimate and the final price tag, and you have given us a break out of some of the factors. Mr. McCredie's piece analyzes some of the categories of increases since 1981.

A. Yes.

Q. And in fact, I think we spoke of this yesterday, it adds up, if we just take the two categories, scope and estimate changes for example, in that period it's been close to $1.9 billion?

A. Correct.

Q. And compared to your release estimate in 1978, if we use that as a base, that's what, 40 per

cent of the release estimate?

A. Well, we are talking, you are comparing dollars of the year in totally different years. I don't see the basis for the comparison. You would have to put it into constant dollars to do that.

Q. What I am really asking here is, can you offer us some analysis of the increases from the release estimate to Mr. McCredie's starting point in '81?

A. Well, I can certainly refer you, if someone can help me with the interrogatory number, to a document that discusses that matter and was in response to the questions set by the Commissioners of ONCI. That's on the record.

I'm sorry, I don't have any way to determine that number.

Q. There isn't a comparable document to Mr. McCredie's that starts with the base of your release estimate?

A. Well, the one I am talking about does. It also does it for Bruce "B".

Q. Would it be possible for you to give us, combine them, if you will, and I have given how many categories there seem to be in mixed dollars, I

would prefer you to do this, would it be possible for you to produce for us something analogous to appendix 5, sub 1, historical cost increases for Darlington GS that captures the changes from the release estimate?

I am fearful that if I look at the piece you did for ONCI, it's going to be all percentages on a different base, and if I combine them you will criticize me for not doing it right.

A. I don't think we should speculate on what we provided to ONCI. I think we should look at what we provided to ONCI.

But I note that in answer to one of the interrogatories that the Coalition asked, which is 9.7.62, for Bruce "B", we provided design and construction costs less interest and with interest from 1976 to 1987.

Q. Let me just stop you there. 9.7.62 is exactly the document that I referred you to before and you told me the number is probably wrong. That's the one that has 3.9 -- rather, I'm sorry, 3.950 billion dollars in it.

A. Well, that's the number for Darlington.

What I am talking about is Bruce "B". That's what you asked me.

Q. No, I am asking you about Darlington. Let's just stick to Darlington, and what I am interested in getting is a historical cost increase analysis --

A. There is attached here significant data here, Mr. Poch, and the third page from the end there is a table entitled Darlington Estimate Review, which starts with a release estimate in 1978, gives an estimate in 1981, change between '78 and '81, the estimate review in '83, the change from '83 to '81, right up to the present date, and it breaks it down in terms of dry capital cost, interest, and it tells you the reasons why these estimates changed.

I am afraid I'm not understanding what more you want.

Q. First of all, that's got this number you have told me that's based on a number you have told me is wrong. Second of all --

THE CHAIRMAN: Which number has he told is wrong?

What is that interrogatory you are reading? Let's go back. What interrogatory are you reading?

MR. PENN: I am reading, Mr. Chairman, from Interrogatory 9.7.62.

THE CHAIRMAN: Which has already been entered.

THE REGISTRAR: That's already entered, that's .74.

MR. D. POCH: Unfortunately, Mr. Chairman, neither nor I have the full interrogatory in front of us right now.

MR. PENN: Well, because CEG only chose to put in their exhibit one sheet.

MR. D. POCH: Q. We have provided your revision sheet, Mr. Penn, which I am now told you are going to have to revise again.

THE CHAIRMAN: Let's take it one point at a time.

Now, Mr. Poch says that you said some number was wrong. What number was that that you said was wrong?

MR. PENN: I was informed at lunch time -- do you have it front of you, Mr. Chairman, page 1? It's on....

MS. HARVIE: It's page 81 of Exhibit 578, Mr. Chairman.

MR. PENN: Thank you.

THE CHAIRMAN: Yes, I have got it now. That's the $4 billion estimate that was made in '78

that should be five something.

MR. PENN: Yes. We will find the exact number. I was just told at lunch time that I had quoted that number and it was for design and construction costs only.

THE CHAIRMAN: And that's what Mr. McCredie says in 539, is that not right, when he says that the earlier estimates were developed for planning purposes and this estimate made in 1981 was the first to incorporate basic engineering design.

MR. PENN: He certainly said that, sir. But this was an earlier one to the definitive--

THE CHAIRMAN: Okay.

MR. PENN: --and I am informed that if you add in the operations estimate, that it approximates to $5 billion.

THE CHAIRMAN: Okay. All right.

MR. D. POCH: Q. And what I am asking for, Mr. Penn, is if you could take Mr. McCredie's table, appendix 5, sub I --

MR. PENN: A. But if I may, Mr. Poch, because I pointed out that this table that is attached to this interrogatory, it clearly describes dry capital costs. There is nothing wrong with that table.

Q. Well, let me just be clear here. Mr.

McCredie's appendix is not just dry capital costs, I take it, is it?

THE CHAIRMAN: Which table are we now looking at?

MR. D. POCH: Appendix 5, sub I of 539.

THE CHAIRMAN: That's right.

MR. D. POCH: Q. He is dealing with the full 13.8 billion, and the change of 6.4 between '81 and '92.

MR. PENN: A. It also includes production branch costs.

Q. And I guess what I am asking then is simply, if you could take the information contained in 9.7.62 with the corrections that you tell us are going to be provided to you, and once you have the corrections, would you combine that with the information that Mr. McCredie has offered us, so we can just have one chart which goes from '78 release estimate, captures all these historical cost increases from that release estimate, and breaks it apart as Mr. McCredie has done, so that we don't have this problem of speaking in different --

A. What is your reference point in this comparison?

Q. Release estimate in 1978.

A. But the release estimate in 1978 assumed in-service very much earlier.

Q. That is fine. That's just as Mr. McCredie's did, and he shows, breaks apart interest and so on, schedule change factors. Mr. McCredie's did that too, I take it; right?

A. The reason that Mr. McCredie did it relative to the 1981 definitive estimate is because the definitive estimate is the official measure of measuring the progress of the project.

The release estimate is exactly what it says, it's a start of release of funds to start developing the engineering and doing the early negotiation for contracts, and it is to start us off to firm up the cost of the project.

So that the release estimate isn't a measure to measure the total project cost by. Obviously, it can be done, Mr. Poch. We then have to wrestle with the question of how we interpret it.

Q. Mr. Penn, I thought you already agreed that a number of the cost estimates you have given us for the competing options are more analogous to conceptual estimates, not even release estimates?

A. I don't think I said that.

What I said was that the 4 by 881 cost

has a very large base since it started with Darlington and it has five years of study behind it.

The other costs that we have got from other vendors is based upon very significant work that the vendors have done with Hydro's costs on them.

So I wouldn't class those costs that I have, those estimates that I have given at this hearing as conceptual estimates. They are based in the case of the CANDU 3, for example, AECL has completed more than 85 per cent of the design. In the case of the advanced boiling water reactor by General Electric, 90 per cent of the design is complete.

Q. How much of the Darlington design was complete when your board released that project?

A. I would say it would be less than 10 per cent.

MR. D. POCH: Mr. Chairman, I am not going to press that, thank you.

THE CHAIRMAN: Can we stop for the day then?

MR. D. POCH: Yes, Mr. Chairman.

THE CHAIRMAN: Thank you. We will continue tomorrow morning at ten o'clock.

THE REGISTRAR: This hearing will adjourn until ten o'clock tomorrow morning.

---Whereupon the hearing was adjourned at 5:03 p.m., to be reconvened on Thursday, April 9, 1992, at 10:00 a.m.

JAS/RR [c. copyright 1985]

E R R A T A
and
C H A N G E S

To: Volume 128

Date: Monday, April 6th, 1992.

Page No.	Line No.	Discrepancy
(v)		insert Exhibit 520.47: Interrogatory No. 9.44.3. Page 22466